Lessons Learnt: Past Energy Transitions in the Gas Industry

A collaborative project between Wales & West Utilities, WSP and Northern Gas Networks.

WALES&WEST UTILITIES

Foreword

This project started as a discussion between Jane Mort of Cadent Gas and Russell Thomas of WSP, who thought there may be lessons that could be learned from looking at the conversion from town gas to natural gas in the 1960s and 70s. After initial work to draft a paper, it became clear this was a vast subject requiring further exploration. This led to a Network Innovation Allowance funded project promoted by WSP and Wales & West Utilities (WWU), later supported by Northern Gas Networks (NGN). It has provided an opportunity to review a range of media to understand how the gas industry changed between nationalisation in 1949 to a period of rapid growth following conversion to natural gas.

Lessons Learnt: Past Energy Transitions in the Gas Industry.

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Executive Summary

With the growing climate crisis, society needs to reduce its dependence on fossil fuels and move to forms of energy with lower environmental impacts. As we enter a period of transition in the energy industry, this move is another step in the sector's evolution over the last 200 years.

The gas industry was established in 1806, originally just for lighting before the growing threat of competition from electricity saw gas begin to be used for heating and cooking by the end of the 19th century.

New and improved methods of gas manufacture from coal developed abroad and in the UK were adopted during this period. These changes included variety in the composition of manufactured gases, which were blended to produce town gas. Coal gas, which formed the bulk of the town gas supply, primarily consisted of hydrogen, methane and carbon monoxide. Producer gas and carburetted water gas was often blended with coal gas to create town gas.

Then in 1949, the British gas industry was nationalised, amalgamating more than 1,000 different private and municipal gas undertakings, most of which operated their own independent distribution networks. Nationalisation grouped these into 12 independent regional gas boards, coordinated by the Gas Council. Each gas board constructed regional networks to connect the independent areas, supplying them with fewer, larger and more efficient gasworks. These regional gas networks were critical to the future transitioning of the gas network.

In 1960, the gas industry was still manufacturing 90% of its gas from coal, with the remainder coming from oil to meet peak demand. The quality and quantity of the available gas coals had been diminishing since WW2, which forced the industry to look for alternative feedstocks. These ranged from low-grade coals that were typically unsuitable for gas making to refinery by-products and natural gas. Refinery by-products were cheaper and so marked another transition.

Meanwhile, in 1959, Liquefied Natural Gas (LNG) was being imported from the USA in a pilot trial. It was also imported at a commercial scale from Algeria to Canvey Island, which supplied 10% of Britain's gas demand. This gas was transported through the newly constructed National Methane Pipeline before being reformed into town gas for distribution, since it could not yet be burned by gas appliances.

If the gas industry was going to replace town gas, it would need to tie itself to a single feedstock – natural gas – and remove the flexibility of being able to switch between

feedstocks such as coal and oil. The discovery of extensive supplies of North Sea natural gas cemented the future of the industry and, in 1966, Sir Henry Jones announced the conversion of the existing gas infrastructure to natural gas.

This decision was made with little consultation, despite needing access to every home and premises on the network to survey and convert the infrastructure and appliances. Gas users were faced with an ultimatum; switch to natural gas and accept the inconvenience of the changeover or choose another fuel source and absorb the resulting cost and disruption.

The main conversion programme took place from 1967 to 1977 and was regarded as one of the UK's biggest post-war engineering projects.

The Gas Council and regional gas boards undertook extensive research on the direct use of natural gas, starting with domestic and commercial appliances at the Watson House Research Station and industrial appliances at the Midland Research Station. These findings laid the foundation for learnings across regional boards and for conversion engineers.

Ahead of the main conversion programme, a series of pilot trials were undertaken – the first, at Canvey Island in 1966, which was next to the LNG import terminal and had a guaranteed supply of natural gas. The second, a much larger pilot trial at Burton on Trent, was near one of the new natural gas feeder mains. Burton on Trent offered a more realistic view of large-scale conversion, providing practical experience and identifying a number of challenges.

Structural changes were also made to the industry before conversion, including its reorganisation in 1973 into the British Gas Corporation. Regional gas boards passed some powers to the Gas Council and negotiated as a single customer rather than as twelve competing customers. This led to greater coordination and consistency between the Gas Council, the National Gas Transmission Systems (NGTS) and the boards who needed the natural gas supply.

Every gas installation and appliance in every premises in the UK was inspected as part of the programme, highlighting concerns over their condition, maintenance and installation. This process identified the need for remedial action and, once complete, vastly improved the country's gas infrastructure. The differing properties of natural gas and town gas also led to improved features on appliances. Customers were also offered discounts to buy new bi-fuel appliances, which were easier to convert.
The regional gas boards were bound by the Gas Act of 1948 to cover the cost of converting domestic customers to natural gas. This covered surveys, changes to the

meter and supply pressure and the conversion of appliances. Many of the disputes that arose from the conversion programme related to the inadequate fitting of existing appliances before conversion, where customers were expected to pay for rectification work (Elliot 1980).

During 1969 and 1970, the conversion experienced higher-than-expected rates of call back, causing a backlog and temporary hiatus in the North Thames area. This, combined with public concerns over the safety of natural gas fuelled by adverse media coverage, initiated a public enquiry on gas safety. The resulting Morton Report was published in 1970 and the Gas Safety Regulations later introduced in 1972 helped dispel these fears.
Some 20,000 people were employed for the conversion – twice as many as initial estimations. Recruited staff were expected to have the right combination of skills and character for working in customer homes. Engineers worked long hours and lived a nomadic lifestyle while the conversion programme moved from sector to sector. The programme was almost a self-sufficient travelling town of workshops, control centres, administrative functions, stores and logistics.

The gas network was broken down into sectors to be converted based on the expected workload, based on the number of consumers at first but later the number of appliances and complexity of conversion. Sequencing was based on several key factors, including availability of natural gas from the NGTS, capacity, demand, maintenance of supply, existing gas supply contracts and load capacity of newly converted industrial areas. Alternative gas supplies were used during conversion, such as LNG and propane/air mix.

There were many unforeseen problems during conversion – lack of parts, industrial disputes, loss of trained staff and the 1970s energy crisis all impacted progress. Switching from a wet town gas to a dry North Sea gas led to unexpected consequences on the mains network, such as leaking from lead yarn joints and the need for safety odorant.

However, there were also undoubted health and environmental benefits. Following the Clean Air Act of 1956, there was a drive to move consumers to smokeless fuels such as coke (a gas industry by-product), electricity and gas. This, combined with town gas becoming cheaper with the development of gas reforming technologies, drove up gas sales prior to conversion.

Conversion more than doubled the capacity of the gas network by increasing of the calorific value of the gas and increasing the pressure of the gas in parts of the network. By not building a new town gas plant, the gas industry saved the equivalent of £1.4 billion. The government saved an estimated £100 million per year in foreign currency conversion costs, money that would otherwise have been spent on importing oil and gas. After conversion, customers received a discount on the price of gas and new easy to convert bi-fuel appliances. Everyone benefitted, which helped make the inconvenience of conversion easier to accept.

By 1980, natural gas made up more than 30% of the total UK energy supply – a huge increase from the 7% pre-conversion. This was higher again for domestic customers, where gas accounted for 50% of the market by 1980. Natural gas allowed customers the opportunity to switch to a cleaner and more convenient fuel for heating and cooking, moving away from more polluting coal and oil. This applied equally to domestic, commercial, and industrial customers.

The success of the conversion programme was a coordinated effort by the state, the gas industry, manufacturers, suppliers, contractors, and a skilled workforce, combined with methodical planning and clear public messaging with consumers at its core.
The programme had its challenges, but according to the Under-Secretary of State for Energy at the time Gordon Oakes, it was a great success. He said in the House of Commons:

"I should like to take this opportunity of praising the gas industry for the miracle it performed in converting the country from town gas to natural gas. It was one of the smoothest operations of the kind in the world. Of course, there were accidents and complaints. Every hon. member received letters from aggrieved consumers, but we put the number of such complaints at one in 1,000. The remaining 999 consumers were perfectly happy with the fuel being supplied to them."

Ultimately, the natural gas conversion programme showed how the seemingly impossible task of converting 13 million customers and 40 million appliances between two gases of differing properties in 10 years could be made possible.

This project seeks to assess what learning can be gained from the programme and how it may be applied to any future energy transition. It could provide a blueprint for a conversion strategy that considers the technical, logistical and communications challenges. It also seeks to assess how securing a sufficient and expertly trained workforce and changing the training and safety standards could enable a smoother transition. While there will obviously still be technical challenges, this study aims to show how long-term planning, clear and coherent communications across the industry and government support are crucial to the success of any conversion programme.

1. Introduction

As the threat of climate change increases, the energy sector faces a period of great change. We need to reduce our dependence on fossil fuels and transition towards new forms of energy that have less environmental impact.

The gas industry faces a dilemma: it can transition to low-carbon gases such as hydrogen and biomethane or it can relinquish its role as an important energy carrier, rendering this valuable national infrastructure obsolete. This challenge may seem unique, but it is just the latest in a series faced by the British gas industry throughout its history.

While there is still debate on the role of green gases in any future energy transition, the British gas industry has long been accustomed to using different types and mixtures of gases. This report looks at the main challenges to the industry from the end of World War II to the completion of the natural gas conversion programme in the late 1970s and aims to show how lessons learnt from the past can facilitate a successful energy transition in future.

A wide range of media, much of which is not readily accessible, has been used to inform this report. This includes gas industry publications, books, journals and transactions papers, in-house magazines, and films. As the gas industry in the United Kingdom embarks on its path to a cleaner, greener energy future, this literature tells an invaluable story.

2. The Evolution of the British Gas Industry

Our modern distributed energy industry first started to evolve in 1812, with the establishment of the first public gas company, The Gas Light and Coke Company (GLCC), by Royal Charter. The GLCC started production on the last day of 1813, lighting the cities of Westminster and London and parts of the Borough of Southwark. It constructed three gasworks that supplied streetlights, public buildings and wealthy households with gas through a series of underground distribution pipes, creating a model for all future energy utilities.

GLCC's engineers pioneered many of the early solutions, such as building gas distribution networks using underground pipes, developing governors for regulating gas pressure in mains and using gas meters to measure production and consumption. The business model of the GLCC was replicated many times; first in London, then in provincial towns and cities and finally abroad.

Gas was primarily produced from coal through thermal distillation in ovens called retorts. The gas was purified, stored in gasholders and then supplied to customers through the network. The coal gas, otherwise known as town gas, typically had a value of 500 British Thermal Units per cubic feet (Btu/ft^3), equivalent to 18.6 Megajoules per cubic metre (MJ/m^3).

Throughout the industry's first 125 years, gas making processes evolved significantly. The report 'The Manufactured Gas Industry', published by Historic England (Thomas 2020a), describes this period in detail:

During this period, the gas industry had to adopt new, more efficient manufacturing technology to meet growing demand. Considerable innovation was required to move from the initial horizontal cast iron retorts operating with radiant furnaces at 600°C to much more efficient producer-fired high temperature retorts (1200°C) made from fireclay and silica. Many other developments in retort design were undertaken. Using both inclined and vertical retort systems, it reduced the ground space required and labour costs through the use of gravity to aid the loading and unloading of the retorts (Thomas 2020b).

Peak demand was met through improved gas storage (thanks to of larger gasholders) and the adoption of blue water gas (BWG) and carburetted water gas (CWG) technology. BWG and CWG were processes perfected in the USA, the latter being an oil-enriched version of the former. Both could be brought into operation in hours rather than days.

These new processes had their challenges as the gases produced had five times more toxic carbon monoxide gas, than coal gas (Table 2.1). Concerns arose when it was proposed to supply this type of gas to customers directly instead of coal gas. This was resolved by blending and diluted the gas with coal gas prior to distribution, which reduced the carbon monoxide concentration whilst increasing gas production.

Table 2.1. Composition of various manufactured gases (from Ward 1960)

Non - combustible components	Producer Gas (Marischka)	Blue Water Gas	Carburetted Water Gas	Hall (Oil)	Coal Gas	Natural Gas
Carbon dioxide	5.7%	5.0%	6.7%	4.1%	2.0%	0.8%
Oxygen	-	-	0.3%	-	0.5%	-
Nitrogen	56%	3.5%	6.7%	15.4%	5.5%	2.7%
Combustible components						
Hydrogen	10.6%	50.0%	42.7%	16.0%	51.8%	-
Carbon Monoxide	27.3%	41.0%	32.7%	2.1	7.5%	-
Methane	0.4%	0.5%	4.9%	29.3	27.0%	91.0%
Other Hydrocarbons	-	-	6.0%	4.4%	4.7%	5.5%

The emerging threat to the dominance of gas from electricity in the 1880s required a transition towards using gas for heating and cooking in domestic and industrial markets. When German scientist Robert Bunsen invented the aerated burner in 1855 (Desaga 1857), it demonstrated how gas could be used more effectively due to the higher flame temperature achieved. Used in combination with the gas mantle (see below), this technology was used in many heating applications.

Developed in 1884 by the Austrian scientist Carl Auer von Welsbach, the gas mantle produced a much brighter light by using an aerated burner to heat rare earth metals impregnated into a fabric mantle. This development allowed the gas industry to continue to compete with electricity in the lighting market into the 1950s. Transition to heating not only offset the industry's losses in lighting, it also opened new domestic, commercial and industrial markets.

Figure 2.1 The Hydrogen Production plant built during WWII at the Torquay Gasworks, Devon. Source - National Gas Archive.

The British gas industry used an array of processes to produce gas and hydrogen, methane and carbon monoxide were significant components in the gases it manufactured. These included coal gas, blue water gas (BWG), carburetted water gas (CWG), coke oven gas, producer gas, Mond gas, oil gas and reformed gas (Table 2.1). Most of these were then blended to make the town gas for consumers. During the Second World War, the gas industry also manufactured hydrogen in special hydrogen production plants (Figure 2.1) to inflate barrage balloons used to protect towns, cities, and important infrastructure from enemy aircraft.

While gas manufacturing evolved at a rapid rate, gas distribution did not develop at the same rate. This was because gas undertakings – private or municipally owned gas production and distribution businesses – were largely independent of each other and supplied defined areas with little or no interconnectivity of the gas mains. Only where large districts were supplied by a single undertaking, for example Birmingham, or where one company had expanded by purchasing neighbouring undertakings, such as the Gas Light and Coke Company (GLCC), were improvements viable.

Where smaller gas undertakings were bought by their larger counterparts, the gasworks of the former were closed. Gasholders were retained for storage, while the larger and more efficient gas undertaking would build a new gas main to ensure supply. These networks were typically low-pressure using mains of up to 48 inches (1219 mm) in diameter. (Terrace 1952, Thomas 2020a).

As distribution networks became larger and consumption increased, these low-pressure networks started to become overloaded, requiring larger mains or some form of reinforcement. In these areas, feeder gas mains – often smaller diameter gas mains that operated at higher pressure – were built to supply local low-pressure networks using district governors.

These types of feeder-based distribution networks had been in operation in Britain as early as 1892, when the GLCC established a new 36-inch (914mm) feeder gas main to Stoke Newington to supply new developments. The City of Birmingham Gas Department developed the largest pre-WWII feeder main system, which supplied an area of 200 square miles. It consisted of three trunk mains, each originating at a major gasworks (Windsor Street, Nechells and Swan Village) and supplying different areas of Birmingham (Terrace 1952).

In more rural areas where the density of consumers was much lower, a 50 lb/in^2 (3.4 bar) high-pressure network through small diameter steel pipes was more practical, with customers supplied by service governors to reduce the pressure. Such systems were introduced by the Grays and Tilbury Gas Company in 1913 to connect smaller adjacent gas undertakings to their networks. By 1936, this network was becoming overloaded, so high pressure gasholders (bullet tanks or Hortonspheres) were installed at strategic locations to meet demand.

A similar high-pressure network was adopted by the Swindon United Gas Company, which had purchased many of its neighbouring gas undertakings in a largely rural area. It built a narrow diameter high pressure network from 1937 to supply outlying towns of Highworth, Farringdon and Fairford, later expanded to Cirencester in the North and Hungerford in the South (Terrace 1952).

In the early 20th Century, British coke manufacturers started to follow their continental counterparts, realising the benefits of recovering the by-products of coal carbonization such as coal gas. The by-product coke oven had originally been introduced in Britain at the Bankfoot Colliery in Crook, County Durham, in 1882, but it took many years to be widely adopted in Great Britain.

Originally, the gas by-product was used to heat the ovens and to produce steam on the site, but it was produced in such large surplus that it began being supplied to local gas undertakings. In some cases, this led to the undertaking ceasing gas production except to meet peak demand.

Surplus coke oven gas led to the development of long-distance gas transmission pipelines, at first in continental Europe, where gas from coke ovens was supplied to the towns and cities that required the supply. This was accelerated in areas of Belgium and France, whose gasworks had been badly damaged in the First World War. In the Netherlands, the Staatsmijnen (State Mines) developed a gas transmission network in Limberg and Brabant in the 1930s. With a similar network was supplied by the Hoogovens steel works at Ijmuiden, northwest of Amsterdam (Schippers 2000). These transmission pipelines took advantage of welded seamless tubes for the construction of pipelines, developed in the USA. A similar approach was then adopted in Great Britain.

Two early developments taking advantage of this surplus gas in Britain were the Sheffield Gas Grids (Figure 2.2) and West Yorkshire Gas Grid (Figure 2.3). The former were operated by the Sheffield and District Gas Company (SDGC) and were split into two grids, one carrying unpurified and the other carrying purified coke oven gas. The SDGC had absorbed 12 of its neighbouring gas undertakings, growing its supply area. It started taking crude coke oven gas in 1918 but did not build the grid until 1932. Some 124 miles of mains supplied 13m cubic feet of gas per year, which was purified at three Sheffield gasworks and one gasholder station. The crude gas grid also supplied four gas undertakings the SDGC had absorbed, with the gas purified at the former gasworks sites of those undertakings (Terrace 1952).

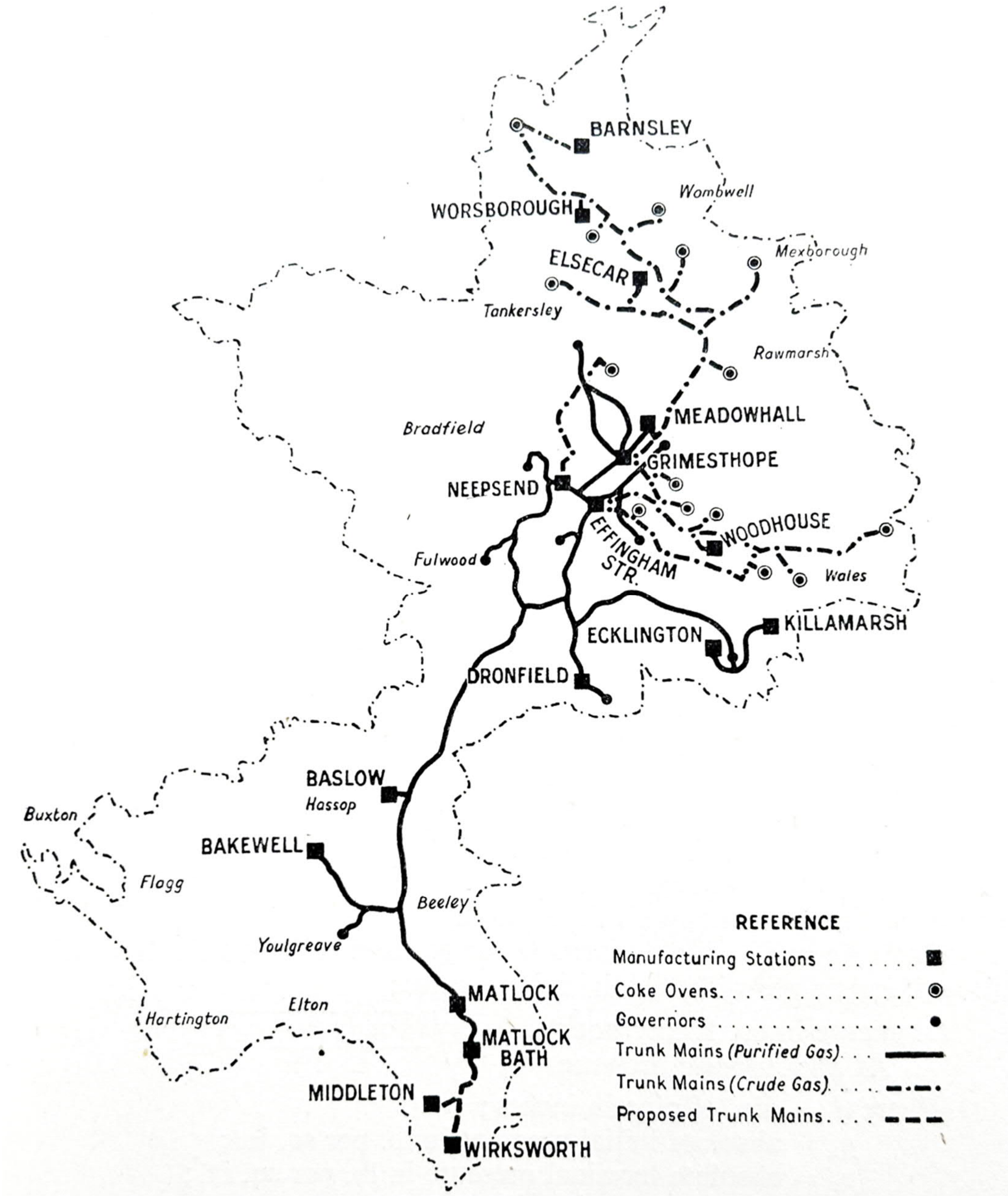


Figure 2.2 The Sheffield Gas Grid (Terrace 1952). Source – Russell Thomas

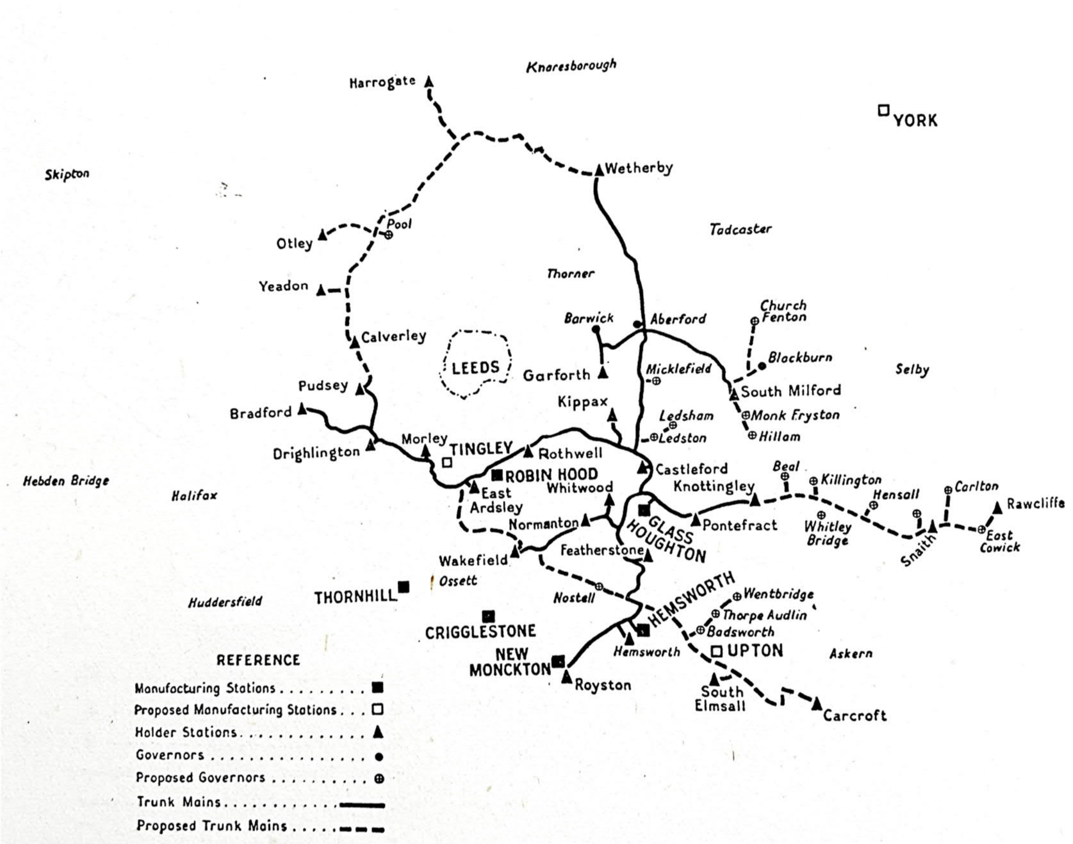


Figure 2.3 The West Yorkshire Gas Distribution Grid (Terrace 1952). Source – Russell Thomas.

The West Yorkshire Gas Distribution Company was devised by Colonel W. M. Carr, the Managing Director of the United Kingdom Gas Corporation (UKGC). It was the first Statutory Gas Distribution company, which was incorporated under the West Yorkshire Distribution Act of 1938. As a business model, it was a forerunner of today's Gas Distribution Networks. It collected surplus gas from coke ovens and gasworks across West Yorkshire and distributed the gas to local undertakings.

3. The Post War Development of the Gas Industry in Britain

3.1 Nationalisation and rationalisation

On the 12th of June 1944, Gwilym Lloyd-George (Minister for Fuel and Power) appointed the Chairman of Unilever, Geoffrey Heyworth, to conduct a review of the gas industry. It aimed to assess its structure and organisation and advise what changes were necessary to develop and cheapen the cost of gas for all consumers (Peebles 1980, Williams 1981, Wilson 2002 pp155-162). The review concluded the gas industry in Great Britain was in crisis. Most gasworks lacked investment, especially through the war years, they were inefficient and gas production was expensive.

The review was presented to Parliament in December 1945 by Emmanuel Shinwell (Minister for Fuel and Power). It highlighted many issues with the gas industry and concluded the existing structure was restricting progress and a fundamental restructure was the only way to stimulate efficient change. The suggested approach was to group gas undertakings into larger units, a view shared by the industry and consistent with the trend towards integration into larger companies such as the GLCC and UKGC (Heyworth 1945, Smith 1958, Peebles 1980, Wilson 2002 pp155-162). According to the 'Report of the committee of enquiry into the gas industry, Heyworth 1945':

"The next consideration is how larger units are to be brought into being. No voluntary process is likely to be sufficiently speedy to satisfy present and future requirements. The reason for this is that the difference in structure between the statutory companies and the municipal undertakings is a basic one and it is unrealistic to expect such a change of climate as will make possible fusion between them in any form likely to be effective.

The committee suggested that: *"Pre-determination of boundaries is the only approach that will produce a workable pattern.".*

A gasworks needed to produce at least 1,250,000 therms (1 therm = 105 Megajoules) per year to secure even basic efficiency and more than 600 of the UK's undertakings did not meet these criteria. At the time of the enquiry, the size of undertakings ranged from the massive GLCC, which accounted for 12% of gas production, to small village gasworks with a single employee. The enquiry recommended the purchase of all existing gas undertakings by Government and organising them into nine regional boards in England and Wales and one in Scotland (Heyworth 1945, Peebles 1980, Wilson 2002 pp155-162). Similarly, the Association of Gas Corporations published a proposed reorganisation in the document 'Reorganisation of the Gas Industry' in 1946, calling for a route where it could be kept under private control (Anon 1946).

Figure 3.1 A Map Showing The Twelve Regional Gas Boards, Established After Nationalisation. Source - National Gas Archive.

The incoming Labour government decided nationalisation was the best course of action for the gas industry. Thanks to the Gas Act of 1948, this happened on 1st May 1949 and split the industry into 12 regional gas boards (Figure 3.1) rather than the 10 proposed. Each was an autonomous body with its own chairman and board structure and had three main duties (Smith 1958):

i. To develop and maintain an efficient coordinated and economical system of gas supply for their area and to satisfy, so far as economically viable, demands for gas in their area.
ii. To develop and maintain the efficient, coordinated, and economical production of coke, other than metallurgical coke.
iii. To develop and maintain efficient methods of recovering by-products obtained in the process of manufacturing gas to ensure revenues of the board would meet the outgoings year on year.

The Gas Act of 1948 also brought about the Gas Council, which aimed to maintain communication between the regional gas boards and the Ministry of Fuel and Power. Its first chairman was Sir Edgar Sylvester and its board consisted of the regional chairs of each gas board (Smith 1958, Peebles 1980, Williams 1981, Wilson 2002 pp155-162). The Gas Council's specific remit was (Smith 1958):

- To advise the Minster on questions affecting the gas industry and matters relating thereto.
- To promote and assist the efficient exercise and performance by regional gas boards of their functions.

The Gas Council also had powers to perform services for, or act on behalf of, the area gas boards concerned in matters of common interest.

This structure was experimental and was considered a form of cooperation by consent. All regional gas boards had to work together to progress the industry, collaborating on research, finance, training and education (Smith 1958).

Figure 3.2 The New Swan Village Gasworks built by the WMGB. Source - National Gas Archive.

While the gas industry in Northern Ireland faced similar challenges, it was not included in Nationalisation in 1949. Instead, it stayed a mixture of privately and municipally owned gas undertakings with limited integration. The gas industry in Northern Ireland has a different history, which led to its total failure in the 1980s, then rebirth following the introduction of natural gas from Great Britain via an interconnector, which is not covered in this paper.

Nationalisation of the British gas industry allowed competitive funding streams, such as those of the British Electricity Authority (BEA) and British Coal. Following nationalisation, the gas industry went through the recommended programme of repair and modernisation. The first year saw a turnover of £233 million and a small profit of £1.9 million (Davis 1968).

By 1958, investment in new gas making plants alone reached £190 million and 20,000 miles of gas mains were laid at a cost of around £100 million. New connections led to the closure of smaller gasworks, such as the Swan Village Gasworks (Figure 3.2) built by the West Midlands Gas Board (WMGB) (Smith 1958). Between 1949 and 1960, the gas boards closed 622 smaller gasworks. In the same year, profits reached £5.5 million on a turnover of £388 million and sales of 2,651m therms (1 therm = 105 Megajoules). And for the following years, the industry alternated between deficit and profit (Davis 1968, Thomas 2020a).

Meanwhile, increasing prices and lack of previously abundant gas-making goals caused growing concerns. The industry needed a new strategy.

In a bid to improve performance, the British gas industry looked abroad for inspiration. In 1952, the British Gas Industry Productivity Team visited the USA (Figure 3.3), giving them an insight into every aspect of the newly transformed American natural gas industry. The visit demonstrated gas manufacturing techniques across the USA and how large regional and transcontinental gas pipelines were used for natural gas. Natural gas made a considerable impression with the team, with the final report stating:

‘Although there are no appreciable known reserves of natural gas in Britain, a discovery of any magnitude would be of immense benefit to our national economy and it is suggested that prospecting, where there is any possible hope of success, should continue to receive vigorous support’ (Anon 1952).

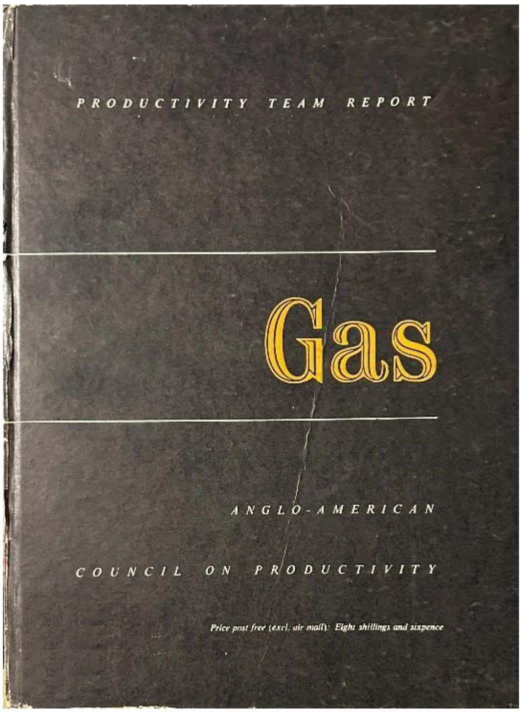


Figure 3.3 The Gas Productivity Team Report Published by The Anglo-American Council on Productivity. Source - Author.

3.2 All options are open

Attempts to find local oil and gas fields in Great Britain continued into the 1950s, but they only uncovered small gas fields, so the industry began looking at importing natural gas from abroad. In 1952, The Gas Council engaged Dr G. M. Lees, Chief Geologist of the Anglo-Iranian Oil Company, which led to a proposed 55-year collaboration between the Gas Council and the Anglo Iranian Gas Company to search the UK for on-shore oil and gas (Smith 1953).

While options for future gas sources were limited, continued sourcing from coal would mean lower grades of coal would have to be used and new technology adopted. Alternatively, the by-products of the oil refining industry could be converted into town gas. The third option was to switch to natural gas. There were, however, no significant local supplies of natural gas at the time. The feeling was to keep all options open, so gas manufacture was not dependent on a single feedstock (Gas Council 1965).

The Gas Council's ongoing search for natural gas continued to rouse interest in a potential new feedstock. An article in the NWGB *Link-Up* magazine highlighted only small supplies of natural gas had been found in the £1 million drilling programme coordinated by The Gas Council and that it was thought unlikely large amounts would be found. However, such a discovery would signal a new era of prosperity and rapid growth of the industry, which was later proven true (Anon 1956).

Figure 3.4 The high-pressure oil gasification plant built by the SEGB at the Isle of Grain, Kent. Source - National Gas Archive.

Multiple options were being considered and championed by different areas, there was no national consensus, and each regional gas board was looking at its own options based on the resources available to them (Smith 1958). But by the end of 1958, the industry was once again being regarded as a “centre of vigorous activity and innovation, with an expanding future” (Anon, 1958).

For example, the South Eastern Gas Board (SEGB) had developed a large oil gasification plant (Figure 3.4) on the Isle of Grain in Kent, using oil as a feedstock supplied from the adjacent B.P. Grain Refinery (Smith 1958). Also, the Southern Gas Board (SGB) was using steam reforming to convert surplus gas from the Fawley refinery into town gas at their Southampton gasworks (Leach 1958).

At the time of nationalisation in 1949, the Wales Gas Board (WGB) was operating 90 gasworks of various sizes and designs, many of which were inefficient and used mostly coal as feedstock (Wales Gas 1974). Its first challenge was to make gas more efficiently at large gasworks and to distribute this and any available surplus coke across Wales. Coke production was higher than local demand and, as in Sheffield and West Yorkshire, the board developed a transmission network to move gas to areas of demand.

Wales was forward thinking, being the first board in Britain to adopt the bitumen-coated, fibreglass-wrapped steel pipelining methods developed in the USA to build high-pressure pipelines to supply north and southwest Wales. These high-pressure transmission pipelines were extended across south Wales and from north Wales into mid Wales (Jones 1958, Jones and Reeve 1978).

In building 600 miles of gas mains, the board closed 70 of its gasworks. By 1958, some 82% of its gas supply came from coke ovens. As a result, the amount of coal used in gas manufacture dropped from 500,000 to barely 200,000 tons per annum (Jones 1958). Also by 1958, nearly all its gas was manufactured at the gasworks in Maelor in North Wales and Pontypool in South Wales. Some small coal gasworks still operated in remote towns but accounted for less than 3% of gas manufacture. Wales had also adopted the use of methane-rich coal mine drainage gas, which was extracted by the NCB from the Point of Ayr Colliery to be reformed into town gas to supply North Wales Grid in 1959 (Jones and Reeve 1978).

By 1964, nationalisation had a dramatic effect on the number of gasworks operating, with the figure falling from more than 1,000 in 1949 to fewer than 300. (Gas Council 1965).

3.3 The first conversion challenge – from coal to oil

There was a growing realisation in the 1950s that dependence on coal could threaten the future of the gas industry. By 1960, Britain was still manufacturing 90% of its gas from coal (Gas Council 1967). The remaining gas was made from oil using CWG or oil gasification plants, primarily to meet peak demand rather than baseload. A once cheap and plentiful feedstock, coals suitable for gas making were becoming rarer and more expensive. In the 1950s, American gas coals had to be imported on occasions, increasing the cost of gas (Gas Council 1965).

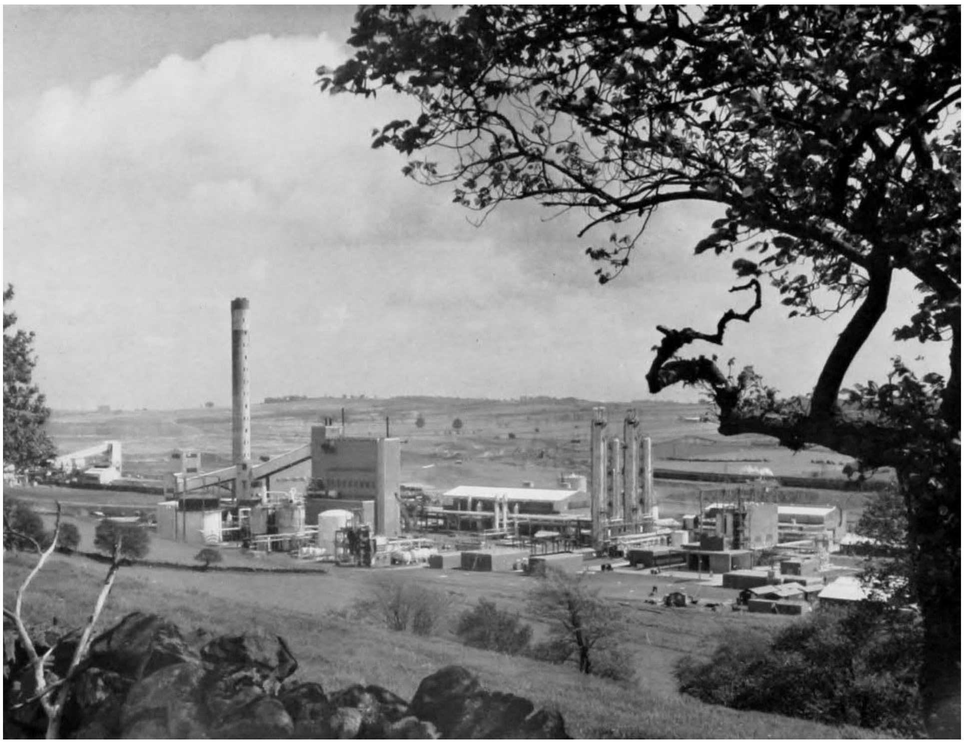


Figure 3.5 The Westfield Lurgi Plant in Fife, Scotland. Source - National Gas Archive.

Some British gasworks trialled gas-making methods from the USA, such as the Hall Process, Jones Process and Koppers-Hasche Process. Alongside this, new catalytic gas-making processes were developed in Britain, such as the SEGAS process developed by the SEGB. Others were imported from abroad, such as those developed by ONIA-GEGI and Micro-Simplex in France, which could use heavy oil or light distillates as feedstock (Thomas 2020a, Thomas 2020b). These processes marked the start of a rapid transition from coal.

Despite these advances, interest in natural gas continued and the gas industry invested considerable money into research and development. This had such an impact that, by 1965, gas was once again regarded as a growing industry (Gas Council, 1965).
The Birmingham Research Station (BRS) focused on the complete gasification of coal under the directorship of Dr F. J. Dent, a chemical engineer, and the former assistant director of the Gas Research Board at their Poole laboratories, where earlier work had been undertaken. The station made a great effort to develop the German Lurgi process, which could use low-grade coals and produce gas at a high pressure (BG Technology 1995).

In 1955, a new Research Station was built next to the Solihull Gasworks, which became known as the Midland Research Station (MRS), which replaced the BRS. Two Lurgi gasifiers were built to continue the work on the complete gasification of coal. These two plants had improved designs, one with a more efficient slagging operation and the second with a deeper fuel bed to improve methane production. This led to the construction of two commercial-scale Lurgi plants, one at Coleshill in Warwickshire, England and another in Westfield (Figure 3.5) in Fife, Scotland (Gas Council 1965, BG Technology 1995).

These plants showed some cost benefits over conventional coal carbonisation plants, which led to further investigations between the Gas Council and the National Coal Board to build a larger Lurgi plant. The study concluded, however, that the cost could not be justified. Research continued at MRS into the gasification of coals to ensure all available feedstocks could be used as required in the future, rather than being wedded to a single feedstock (Gas Council 1965).

The increasing scarcity of quality gas making coals and the boom in the post-war oil refining capacity in Britain led to new oil-based feedstocks becoming available at competitive prices, namely tail gases and light oils. Work at MRS and Poole had investigated the hydrogenation of oils for enriching lean gas from the Lurgi gasifier. Some of the early work had investigated how excess baseload gas could be used for methanol production which, in turn, could be used at times of peak demand (BG Technology 1995).

The initial solution seemed to be manufacture of gas from oil refinery by-products, such as naphtha, primary flash distillate, propane and butane (Gas Council 1965). The Gas Council funded the development of four related processes, which included the Catalytic Rich Gas (CRG) process and Gas Recycle Hydrogenator (GRH) process. The former involved passing the feedstock with steam over a powdered nickel-alumina catalyst in a fixed bed reactor at 25 bar and 500°C, with subsequent carbon monoxide conversion to carbon dioxide and carbon dioxide removal. The rich gas was then either used as a fuel gas to enrich lean gas or as a substitute 'town gas' or natural gas.

The first commercial-scale plant CRG was built at Bromley-by-Bow gasworks, London, in 1964. The exothermic process was popular because it was economical and flexible, requiring no external heating. Approximately 50 more such plants were built in the UK and abroad.

These processes, along with other gas reforming technologies, served as a vital stopgap, allowing the country to transition from coal to natural gas and proving the gas industry could innovate quickly to survive (Barash and Gooderham 1971, BG Technology 1995).

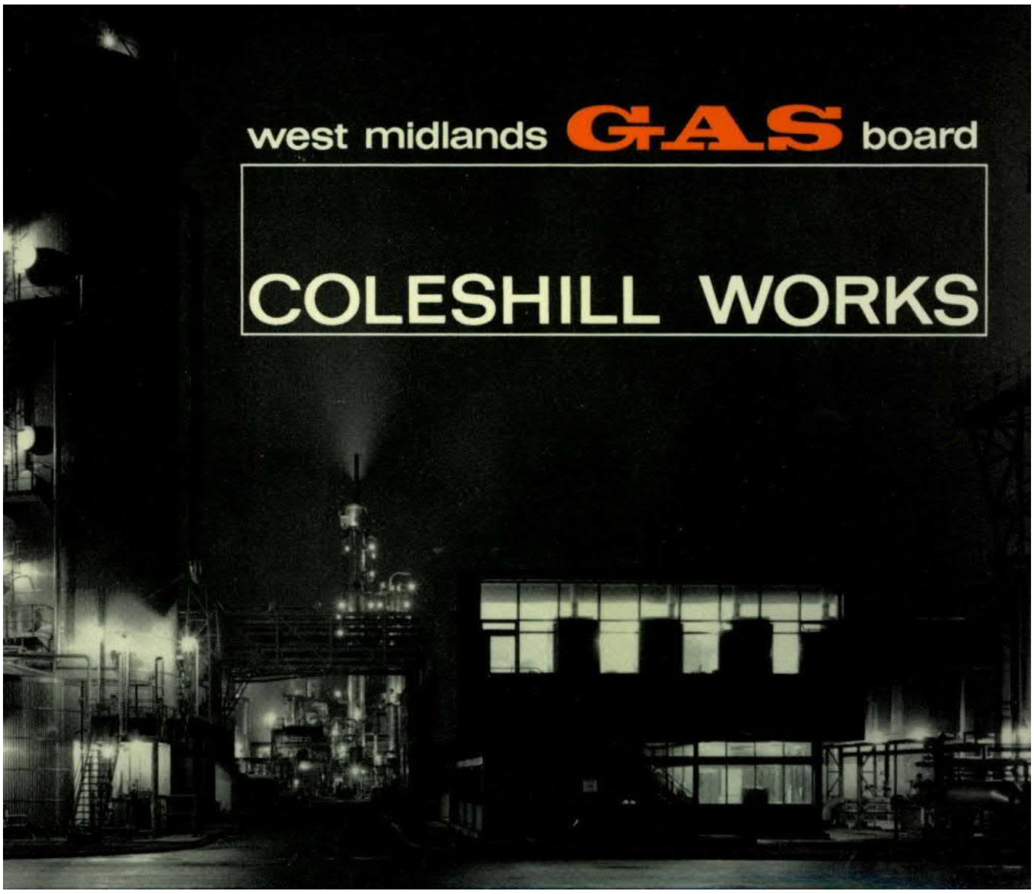


Figure 3.6. Front Cover of the booklet describing the Coleshill Gasworks. Source - National Gas Archive.

The GRH process was a non-catalytic method that used a hydrogen-rich gas to preheat the hydrocarbon feedstock before it entered a specially designed, insulated cylindrical reactor vessel with a central draft tube. This reactor vessel was heated to between 700 and 750°C, within which the hydrocarbon feedstock was broken down into smaller molecules and partially hydrogenated, producing a gas of high calorific value. It was developed at pilot scale at MRS and soon used commercially at the Avonmouth Gasworks, Bristol, in 1965. It was employed at this site and others to enrich the lean gas produced by the numerous Imperial Chemical Industries (ICI) reforming plants installed by the regional gas boards. The ICI reforming plant had been developed in 1962 and used externally heated reforming furnaces containing tubes packed with specially designed ceramic catalysts containing nickel (BG Technology 1995, Thomas 2020b).

Coleshill gasworks (Figure 3.6), built by the West Midlands Gas Board (WMGB), provided a unique opportunity to test both the Lurgi process and the ICI reforming plant head-to-head. Both processes produced a lean gas of approximately 350 Btu/ft^3 (13.0 MJ/m^3), which was enriched to 500 Btu/ft^3 (18.6 MJ/m^3) with either methane (from the National Methane Pipeline) or butane in the case of the Lurgi process or methane, butane or rich gas from GRH in the case of the ICI reforming process. The site had been chosen due to the nearby source of coal from the Kingsbury Colliery and was originally planned only for the Lurgi processes. The changing situation of oil as a feedstock meant the second stage adopted the ICI gas reforming process (West Midlands Gas Board 1965).

In Wales, despite its own vast coal resources, the rising cost of gas coal and its decreasing quality led to a fundamental shift to making gas from refinery by-products. The Pontypool gasworks, which had used a catalytic oil gas plant, was replaced by the new E. M. Edwards high-pressure gas reforming plant near the oil refinery at Llandarcy, which supplied South Wales. The Maelor works at Wrexham supplying North and Mid Wales was overhauled and a high-pressure gas reforming plant replaced the old coal plant. Both supplied their regions through new large diameter transmission mains (Wales Gas 1974).

The economic advantages of reforming petroleum feedstocks using the ICI reforming process was apparent at Coleshill. The reforming plants could be highly automated, saving labour costs, and required only moderate capital cost expenditure. Consumer demands for petrol at this time in Western Europe were weaker in the winter, leading to a surplus of light distillate oils at refineries, which was available for gas manufacture under mutually attractive terms (Gas Council 1965). The gas industry, however, did not want to become as dependent on oil as it had on coal, which helped drive the search for natural gas.

The oil reforming plants proved to be much more cost-effective, and the development of gas reforming technology proved to be the saviour of the gas industry during uncertain times in the 1960s and 1970s and during the transition to natural gas (Elliot 1980).

Customers remained largely oblivious during the switch from coal to oil-based gas production. While demolition of coal gasworks and the promotion of a new 'High Speed Gas' was apparent, the gas they received was fundamentally the same. The network did not need to be sectorised and purged during the change, so customers were unaffected. A parallel could be drawn today, where a move to blended hydrogen would see little or no change for the consumer.

3.4 The development of liquefied natural gas and Canvey Island terminal

Having found no significant local natural gas source, attention turned to the USA, where experiments had been undertaken on the liquefaction of natural gas. By cooling the natural gas to -161°C, its volume could be reduced by 600 times, allowing it to be shipped in tankers. In 1954, Continental Oil and Union Stock Yard formed Constock Liquid Methane Corporation to develop the concept of ocean-going LNG transport. This attracted the interest of the Gas Council which, in 1957, announced a trial to import natural gas from the USA using an LNG tanker.

The J. J. Henry Company of New York redesigned a World War Two liberty freighter originally named Marline Hitch to become the Methane Pioneer, capable of carrying 5,000m^3 of LNG in five prismatic tanks. It took seven cargoes of LNG from Lake Charles to Canvey Island, the first departing in January 1959 and the last setting sail in March 1960. It proved ocean-going LNG transportation was both technically and commercially viable, creating a new industry.

This proof of concept showed importing natural gas to the UK and transporting it several thousand miles was feasible. It persuaded the Gas Council in 1961 to import the natural gas equivalent of 10% of the country's gas demand over the long-term. Attention then turned to a large gas reservoir discovered in 1960 beneath the Sahara by the French/Algerian Societe d'Exploitation des Hydrocarbures d'Hassi R'Mel (SEHR). This was developed into the Hassi R'Mel gas field in Algeria.

Gas was transported by pipeline 200 miles to the Port of Arzew on the Mediterranean, where it was liquefied into LNG. This LNG was exported to Canvey Island and Le Havre in France and this 1600-mile journey was much shorter than the 4000-mile journey from the USA. Some 30 trips were planned annually using two specially commissioned UK-built ships: the Methane Princess and the Methane Progress.

The LNG reception facility at Canvey Island had to be greatly expanded to accommodate this increase in gas imports. It built a 750-foot jetty to receive the tankers and a pipeline to five onshore storage tanks with a combined capacity of 20,000 tonnes. In 1964, a cargo of Algerian natural gas was delivered to Canvey Island (Byford *et al* 1977), which marked the beginning of the UK's journey towards a cleaner, safer, more affordable fuel (Figure 3.7).

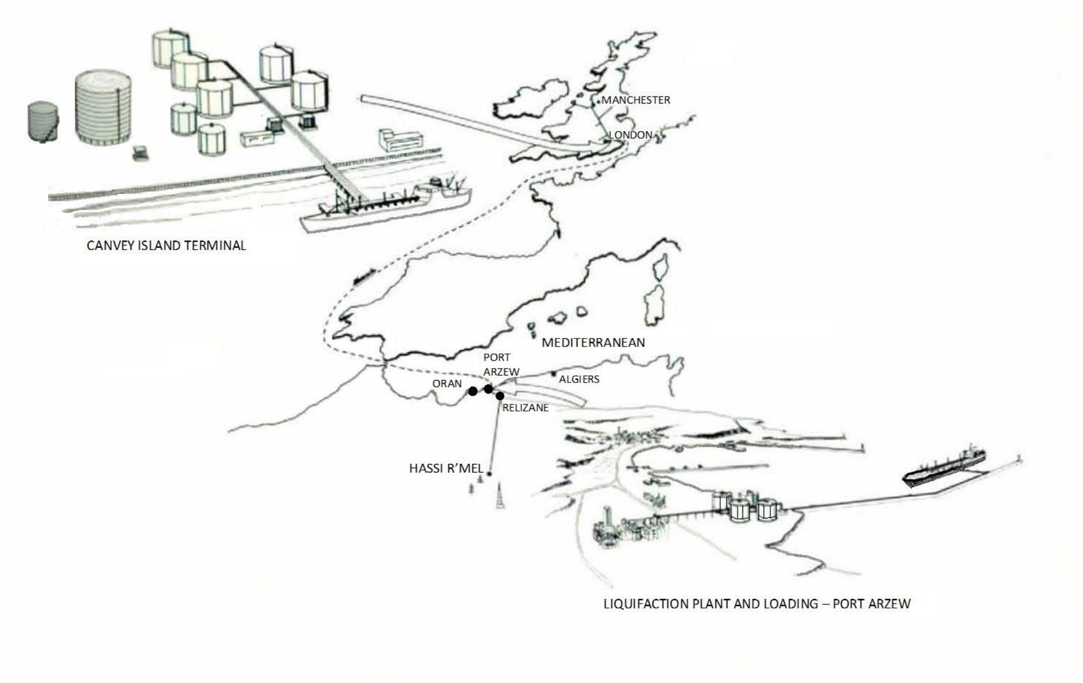


Figure 3.7. A schematic of the import of Gas from Algeria to the UK by LNG tanker, based on a SEGAS Schematic from 1962. Source - National Gas Archive.

Natural gas could not be used directly in the existing gas distribution mains to customers as it had twice the energy density (approximately 1000 Btu/ft^3 or 37.2 MJ/m^3) as that of manufactured gas (approximately 500 Btu/ft^3 or 18.6 MJ/m^3) and the burners used in customer appliances would not be able to burn it safely or efficiently without some form of conversion.

While supplies were limited to LNG imports at Canvey Island, the best option was to transport the natural gas to eight of the regional gas boards via the newly constructed National Methane Pipeline also known as Feeder 1, where it could then be reformed into town gas to supplement existing supplies and distributed to customers. This required the construction of new gas reforming plants at key strategic off-takes from the National Methane Pipeline, such as Coleshill in Warwickshire and East Greenwich in South London.

Natural gas from Canvey Island and the methane pipeline became an important source to maintain Britain's gas supply. When exceptionally cold weather hit Britain in February 1969, British supplies of natural gas became depleted due to temporary shut-off of supplies from the Esso and Shell sections of the Leman Gas Field. Urgent action was required to maintain supplies, so the Gas Council persuaded French LNG tanker the Jules Verne to unload its LNG cargo at Canvey Island rather than its original destination of Le Havre. This returned an earlier favour when British tankers had supplied the Le Havre LNG terminal after the Jules Verne had been damaged in 1965 (Anon 1969a).

While Algeria was one option, the Gas Council also looked to collaborate again with Conch Methane Services Ltd to provide an LNG export facility on the Niger Delta in Nigeria, which could enable the importation of LNG to the UK. Sir Kenneth Hutchison (Deputy Chairman of the Gas Council) and Denis Rooke (The Gas Council's Development Engineer) went to Lagos to hold talks with the Federal Minister of Mines and Power and the Minister of Industries in Lagos and the Premier of the Eastern Region. Developments in the North Sea soon made this idea redundant, but it was clear the Gas Council were considering increasing imports of natural gas (*Link Up* October 1965).

3.5 The quest for North Sea gas

While overseas energy supplies were both useful and important, they were a long way from the amount required to switch to a natural gas economy. Prospecting the UK for both oil and gas had found some small onshore oil fields, but nothing substantial. It was not until the discovery of the vast underground gas reservoir at Slochteren in the Netherlands in 1959 by Shell and Esso that the idea something of significance could be found around Great Britain took hold. This belief was based on hope that the geological features of the Slochteren Gas Field may also be found beneath the North Sea, which could be accessible by offshore drilling platforms (Figure 3.8).

Figure 3.8. The Drilling Rig Orion on the North Sea. Source - Author.

Ownership of the North Sea, however, was uncertain, but due to interest in its mineral rights, the International Law Commission of the United Nations had begun to address this issue. It decided to split the exclusive mineral rights to the six nations that bordered it: Belgium, Denmark, Germany, Norway, The Netherlands and The United Kingdom. These rights were ratified as the Convention of the Seas in Geneva in 1964 (Elliot 1980).

The UK's position earned it a large chunk of the mineral rights to the North Sea. The first licenses were issued to two dozen different groups in 1964 and covered 42,000 square miles of the North Sea and exploration started in earnest. The preliminary expenditure on geological surveys was estimated at more than £100 million, but it soon started to bear fruit with British Petroleum's Sea Gem striking gas 40 miles east of Grimsby at what was to become the West Sole Field. This was able to produce more than 10 million cubic feet of gas per day and justified the construction of an underwater pipeline to bring the gas ashore at Easington Terminal, north of the River Humber. Becoming operational in 1967, the gas was fed into the existing Methane Pipeline at Totley near Sheffield via a 24-inch (609mm) diameter pipeline. Further fields (Hewett, Leman Bank and Indefatigable) were discovered off the Norfolk coast, with gas brought ashore at a facility at the Bacton Terminal built between 1966 and 1967. The Viking field was discovered further north of the West Sole field, with a new terminal built on the Lincolnshire Coast at Theddlethorpe (Elliot 1980).

3.6 The road to conversion

With the abundance of North Sea gas becoming apparent, chairman of the Gas Council Sir Henry Jones announced in 1966 that Great Britain would switch to natural gas. This was not an easy decision, since the gas industry was bound by the Gas Act of 1948 to cover the cost of customers' conversion (The Institution of Gas Engineers 1968).

Natural gas, which was primarily composed of methane, has a very different composition to town gas, which was primarily hydrogen although methane was a significant component, as seen in Table 2.1. The methane that constituted much of natural gas was therefore not new to the industry, but it had little experience using it directly. There was a certain amount of caution about switching the type of gas used despite it long being seen in areas of the USA and the fact it was being adopted in some European countries such as The Netherlands (Elliot 1980). While Great Britain did not lead on the conversion to natural gas, the large scale of the industry made it a bigger challenge than had been attempted elsewhere.

Changes in the composition of the gas had proved problematic previously, when Blue Water Gas (BWG) and its oil-enriched variant Carburetted Water Gas (CWG) had been used in the gas supply from the 1890s onwards. These gases had at least twice the concentration of the toxic asphyxiant gas carbon monoxide than coal gas (Table 2.1), which led to concerns over its safety. To address these, it was usually blended with coal gas to dilute the carbon monoxide concentration.

Composition of gas had varied over time. The first regulations on gas quality were based on the luminosity prescribing gas industry standard of 16 Candle Power in 1871 (1868 in London). This was replaced in 1920 by the Gas Regulation Act, which prescribed a thermal value based on British Thermal Units per cubic feet of gas (Btu/ft^3), equivalent to 0.037 Megajoules per cubic meter (MJ/m^3). Gas produced and supplied as highlighted in Table 2.1 varied and continued to evolve with the use of reformed gas produced from refinery by-products before the switch to natural gas.

Table 3.1 The characteristics of Methane and Town Gas

Characteristic	Methane	Town Gas
Gross calorific value (btu/ft^3)	995	500
Specific Gravity (Air=1)	0.55	0.47
Wobbe number (Btu/ft^3)	1344	730
Stoichiometric air requirement (vol. air, vol. gas)	9.52	4.3
Stoichiometric air requirement (ft^3.1000 btu)	9.57	8.6
Stoichiometric mixture (ft3/1000 btu)	10.57	10.6
Stoichiometric products (ft3/1000btu)	10.57	9.8
Maximum burning velocity (ft/s)	1.115	3.28
Viscosity (lb/ft s)	7.287×10^{-6}	9.206×10^{-6}
Spontaneous ignition temperature	704.4	593.3
Maximum flame temperature, with air (°C)	1948.5	1982
Maximum flame temperature with oxygen (°C)	2776.5	2726.5
Limits of inflammability: Expressed as:- a. % Gas in mixture b. Fraction of stoichiometric air requirement	 5-15 2.10-0.70	 4-40 5.82-0.58

Experience of natural gas in Britain was limited to methane-rich gas drained from coal mines and a small gas field near Whitby. In North Wales, the methane-rich (98%) gas drained from the Point of Ayr Colliery was either used to enrich low calorific value Blue Water Gas or reformed to town gas directly. A similar approach was adopted at Maelor Gasworks near Wrexham, where methane drained from nearby Bersham Colliery was reformed to town gas. This approach was also used at Aberavon in South Wales. Methane drained from the Afon, Dyffryn Rhondda and Glyncorrwg collieries was collected and transported by a pipeline 16.5 miles long to the Aberavon Gasworks, where it was reformed to town gas. Despite these new sources of natural gas, they only accounted for 2.2% of total gas production in Wales in 1958 (Jones 1958).

As with today, there was an environmental imperative supporting conversion in the gas industry. Britain in the 1950s had been struggling with air pollution, which led to the introduction of the Clean Air Act in 1956. This drove consumers to use smokeless fuels such as coke (a gas industry by-product), electricity and gas. Combined with town gas becoming cheaper and cleaner with the development of gas reforming technologies, this drove up gas sales before conversion. When North Sea natural gas was found in substantial quantities with a very low sulphur content, there were undoubted health and environmental benefits from switching as many customers as possible, especially industrial customers, from more polluting fuels to natural gas. This uptake was aided by the likely flows of gas from the North Sea being substantially greater than gas production at the time (Eaton 1967, Gas Council 1971, Elliot 1980).

Consideration had been given to the continued use of reforming plant to change the calorific value and other characteristics of natural gas to those of town gas before distribution, a known solution that was already in use and avoided the need to convert appliances. It could also have been used to enrich low calorific value gases through blending, another option that had been used before (Elliot 1980). If the gas industry was going to give up town gas, it no longer had the flexibility of using different feedstocks such as coal and oil to produce gas and would be dependent on a single feedstock.

However, due to abundance of North Sea natural gas offering a guaranteed supply for decades, the decision was made to switch to natural gas. By using natural gas directly, it removed the need for the construction and long-term operation of costly reforming plants, which would have been required to convert it to town gas. Two other big benefits of conversion were that carbon monoxide was removed from the gas and storage and distribution infrastructure was suddenly able to double energy capacity due to natural gas's higher calorific value. Half the volume of natural gas could be used to obtain the same amount of heat as town gas. (Gas Council 1969, Elliot 1980).

The most significant differences from Table 3.1 are the burning velocity, which is three times higher for town gas than for methane, and the Wobbe number (used to compare the combustion energy output), which was roughly twice that for methane than town gas.

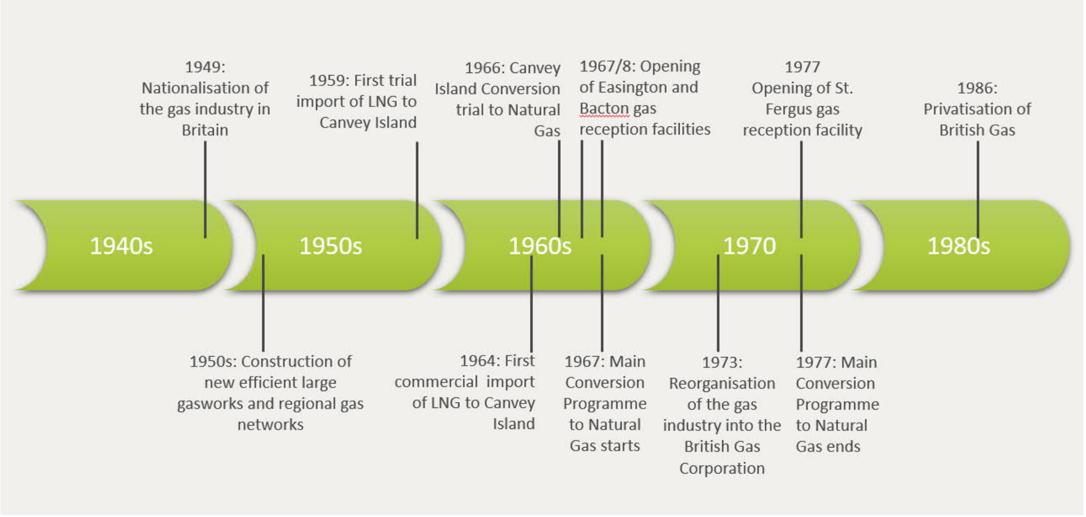


Figure 3.9 A Timeline of events between nationalisation in 1949 and privatisation of the gas industry in 1986, showing the key events during conversion.

The difference in the composition of town gas and natural gas meant the gases had different burning velocities, a safety concern. In converting from town gas to natural gas, the slower flame speed of natural gas reduced the risk of the flame retreating up the gas pipe, but it was necessary to be sure that the burner was stable against lifting off the burner and being extinguished, (Gas Council 1969).

This decision to convert changed the future fortunes of the gas industry, but it required a massive long-term project to switch the gas network and all the appliances connected to it to use natural gas. The reorganisation of the industry following nationalisation and move to fewer larger gasworks had created large networks in the regional gas boards, which made natural gas distribution feasible across most of Great Britain. This, however, would require the construction of a national gas transmission system.

The conversion of a gas network from one form of gas to another was not a first for the British gas industry. The WMGB had previous experience from the conversion of a separate distribution system, which supplied Mond Gas in its region (Appleby *et al* 1964). The Mond Gas Producer Plant was developed by the Belgian Scientist Ludwig Mond in 1889 and its primary role was the production of sulphate of ammonia fertiliser. It also produced large amounts of low calorific value gas, primarily composed of hydrogen and carbon monoxide. It was unsuitable for gas lighting and domestic use but could be used for industry with furnaces and gas engines.

The plant was opened in 1901 by the South Staffordshire Mond Gas Company, inherited by the WMGB at nationalisation in 1949 and closed in 1963. The gas mains and the customers it supplied had to be converted to supply and use richer town gas. In 1963, there were 46 factories using Mond Gas that operated around 700 large gas appliances, such as furnaces. Each of these had to be modified to burn the higher calorific value town gas. This conversion programme was completed over a period of two weeks, which was phased to coincide with the annual summer shut down of many of the factories (Appleby *et al* 1964).

Experience from this project and from the conversion of some remote towns such as Whitland in south Wales, which was converted to a mixture of Liquid Petroleum Gas (LPG) and air in 1952, gave the industry some idea of what was to be expected (Jones and Reeve, 1978).

As well as locating a new source of gas supply, conversion was driven by several other factors, the most significant of which was the need to meet rising demand. It was increasing at 8% per year for the North Thames Gas Board (NTGB), but in some districts where central heating had been installed in a significant number of houses, demand was increasing at 30% per year (Rhodes, 1966). The distribution system was likely to be overwhelmed in a matter of years, so the only viable options to overcome this were:

- To replace the existing distribution mains
- To increase district gas pressures
- To increase the calorific value of the gas.

Natural gas was being considered both as an option for the NTGB and the wider gas network in Britain. Within the NTGB area, a switch to natural gas could treble the thermal capacity of the mains (increasing gas pressure and the high calorific value of the gas). This would resolve some supply issues in the outlying regions that were near capacity and for which growth in sales was expected to be significant (Rhodes 1966).

3.7 The Canvey Island experience – first trial of natural gas

Canvey Island was on the far eastern edge of the NTGB's territory, 30 miles east of London, and covered about six square miles. Being next to the LNG import terminal and start of the original National Methane Pipeline, it was the logical place to undertake a trial conversion due to plentiful supply of natural gas from the LNG storage built at the terminal (Rhodes 1966).

New natural gas supplies from Nigeria or the Netherlands had focused minds on the potential for conversion, which had been reinforced by natural gas finds in the North Sea

(Anon 1965, Rhodes 1966). Nederlandse Aardolie Maatschappij, otherwise known as N.A.M. (Gas Export), and the Gas Council held discussions in 1966 about the possibility of building a gas export pipeline to the UK, but the decision was deferred pending the outcome of North Sea drilling, with reserves held for the UK until January 1967 (Yorker 1966).

Initially the question was how Canvey Island would be converted. Natural gas could be used directly, or it could be reformed to produce a rich gas containing hydrogen and such a plant had already been constructed at the terminal site. The latter option required less work in the conversion of appliances, although some modification would be required, but it would deliver less benefit due to the lower calorific value of gas supplied and it limited any increase in network capacity (Elliot 1980).

The gas infrastructure on Canvey Island was relatively new and had received considerable investment following the flood of 1953, which had caused extensive damage. The network had some 7,850 customers, most of whom were domestic and with many modern houses that had adopted gas central heating. It was also easy to isolate from the rest of the gas network. There was also sufficient allocation of natural gas under NTGB control and enough long-term storage to secure supply (Rhodes 1966, Elliot 1980).

The first surveys on the island started in 1962, commissioned by the Chairman of the NTGB Sir Michael Milne Watson. The eventual decision in 1965 to convert Canvey Island to natural gas was guided by the success in finding viable quantities of gas in the North Sea and the essential need to gain practical experience (Rhodes 1966, Elliot 1980).

The objectives of the trial conversion were:

- To discover the practical problems involved in the conversion of appliances on the district. Watson House, the Gas Council, had already carried out a great deal of development work in the laboratory on the conversion of appliances to burn natural gas, but little experience existed with regards to work on the district.
- To assess customer reaction. Considerable experience in this field existed abroad, but customers in the UK have widely different standards. Appliances, too, are different and in some cases present additional problems.
- To determine the costs involved in conversion.

The time available between the decision in autumn 1965 and the start date proposed for converting appliances in June 1966 was short and inadequate for full and detailed determination of all problems. But the advantage gained by bringing the whole conversion programme forward one year, and in so doing avoiding the need to build expensive new gas plant to meet the increasing peak load (Rhodes 1966), justified this.

Watson House, one of the Gas Council research centres, had been working on natural gas since 1961 and, by 1966, enough information was available to support the first conversion of domestic appliances at Canvey Island (Anon 1969). While Canvey Island was an important conversion for the NTGB alone, it was very much a test run for the rest of Great Britain. A preliminary survey of customer gas appliances was undertaken in 1964, the results of which are shown in Table 3.2 (Rhodes 1966, Elliot 1980).

Table 3.2 Results of Preliminary Surveys (Rhodes 1966)

Item	Preliminary Survey 1964 Number	Final Survey 1966 Number
Meters	6,600	7885
Cookers	6,126	6959
Water heater	3,750	4505
Refrigerators	1,513	1927
Fires	1,042	2696
Portable heaters	485	717
Radiators	179	392
Central heating boilers	143	545
Solid fuels grates	1,088	911
Wash Boilers	1,270	1,203
Washing Machines	144	133
Boiling Rings	346	446
Drying units	201	239
Pokers	425	597
Pistols	548	581
Miscellaneous	785	760

A final survey was carried out in Spring 1966 (Table 3.2), which identified 7,885 customers would be involved and 22,500 appliances would need converting. Property owners, who were not all in favour (Figure 3.10), were asked to sign the surveys to ensure there were no later discrepancies. The surveys revealed a huge variety of equipment would need to be converted – three or four appliances per home, on average. A large proportion were also 15 years old or more, which meant converting all these old appliances or persuading customers to buy new ones by offering generous terms (Rhodes 1966, Elliot 1980).

One of the first issues was that no suitable accommodation for conversion personnel existed on or near the area, so conversion facilities were built in the grounds of the Canvey Island Methane Terminal site. Portable buildings housed i) an administration block, ii) a service unit, iii) stores, iv) a warehouse, v) a workshop and vi) a canteen, typical of what would be required for the main programme (Rhodes 1966).

Publicity and public relations were recognised as being important, so before any public announcement was made of the decision to carry out the conversion exercise, a meeting was held with the Canvey Island Urban District Council to explain in detail what was intended and to gain its support. Following this meeting, the news was released to the press (Rhodes 1966, Elliot 1980).

This meeting was followed up by liaison with pensioners' organisations and other associations on the island, while public meetings were held to tell the conversion story. The Board also cooperated closely with the local police during the conversion period, particularly around vehicle parking. The Board's showroom also hosted a special display on the Island, while Home Service Advisers gave demonstrations for around two months in showrooms and local schools (Anon 1966c, Rhodes 1966, Elliot 1980).

Immediately after the release of the information to the press, customers were informed by letter that the island was to be converted to natural gas. This was followed up by a personal call from one of the Board's representatives to explain in detail what was involved in conversion. A further letter and a postcard giving the exact date of conversion were subsequently sent shortly before conversion was due to take place (Rhodes 1966, Elliot 1980).

Figure 3.10. Customers surveys received both positive and negative responses from customers. Source - National Gas Archive.

After the decision had been made to convert Canvey Island, the NTGB visited manufacturers to inform them of what was required. The experience of Canvey Island highlighted the importance of customer surveys in ensuring the timely availability of conversion kits (Elliot 1980).

Close liaison was invaluable in determining the many and varied problems that arose in connection with the production of conversion kits. Manufacturers devoted a great deal of research and development time to enable production in less than six months. Older appliances presented a problem, since the work required to develop the kits to convert them was not worth the effort given the small number of appliances (Rhodes 1966).

The pre-conversion survey offered the opportunity to sell both replacement and additional purpose-built natural-gas appliances available from the gas showroom. This saved the gas board time and minimised inconvenience for customers. As a result, it was decided to offer the estimated savings due to this efficiency to customers on Canvey Island in the form of a ‘conversion allowance’ on new appliances. Some obsolete appliances were replaced with converted appliances supplied by the NTGB, with customer approval (Rhodes 1966).

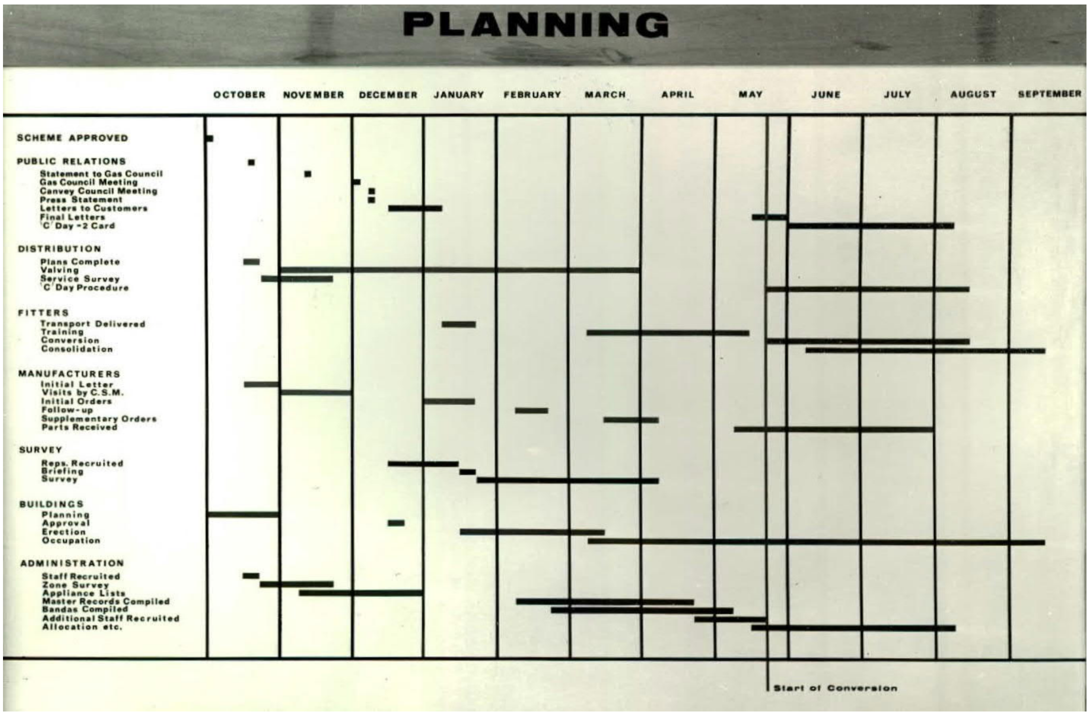


Figure 3.11 Gannt Chart showing the Canvey Island conversion programme. Source - National Gas Archive.

Canvey Island was primarily an area of domestic customers, but it did have a few industrial and commercial customers. These were surveyed by specialist industrial and commercial gas engineers with works general carried out at night or weekends to avoid disruption (Rhodes 1966). The programme for the Canvey Island Conversion is shown in Figure 3.11.

The whole trial was supported by clerical staff who processed the surveys and associated them with customers' accounts and correct road sequence for the conversion. Additional information was sought via a questionnaire printed on the back of the initial survey form to provide further information such as meter particulars, size of service and address for key on conversion day. This was all used to form a master record in the Regional Head Office.

Appliances were delivered from the warehouse at Haggerston, while the gas fitter was given a work summary on which he recorded his travelling time, working time and waiting time each day. Fitters were asked to record the time spent on converting each appliance separately so the cost of individual appliance conversion could be assessed. Gas fitters were drawn from the Canvey Island division and two adjacent divisions of the NTGB. While they were available, since the summer months were typically less busy, they required training in conversion techniques on a two-day course. The relatively brief training requirements were due to them being experienced gas fitters with a high level of knowledge of the gas systems and appliances they were dealing with.

Figure 3.12 The Canvey Island Conversion Workshops, During an Open Day. Source - National Gas Archive.

Using data from the customer survey findings and knowledge from conversions undertaken in the laboratory, the Board estimated the number of hours labour needed to undertake the conversion programme. From that, it determined 250 fitters would be required to undertake the conversion. It had been estimated up to 1,500 appliances would need to be converted in the site workshop, but difficulties converting wash boilers and most gas fires led to four times that amount being brought into the workshop, as shown in Figure 3.12 (Rhodes 1966).

The island had to be divided into 24 sectors of between 300 and 400 customers so the work could be carried out without undue inconvenience to the public. Its gas network was split into two entities: 1) a low-pressure network supplying 3,400 customers at 6-inch water gauge pressure (0.014 bar) and 2) a high-pressure network operating at 25 lb/in^2 (1.72 bar) supplying 4,450 customers. The high-pressure network used high to low pressure regulators were fitted to each premises typical of rural high-pressure network using narrow service pipes (Rhodes 1966, Terrace 1952).

The conversion team also had to investigate the mains system to find the best way to introduce natural gas in stages round the island while maintaining an adequate supply of town gas to the other areas. This was not an issue as an 8-inch main had recently been laid to reinforce the existing distribution system and it was used to introduce natural gas by stages throughout the area (Rhodes 1966).

The team needed to ensure as far as possible that the sectors were completely isolated. They did this by reducing pressures during a low-consumption period to a safe minimum, shutting off the main valves and watching for any build-up of pressure that would indicate a feed from another sector. This preliminary distribution work took around three months to complete (Rhodes 1966).

When it came to conversion day, the Board considered it necessary natural gas was available at the consumers' premises and the cooker at least was working by the evening. Gas fitters called at each house at 8am and turned off the main gas control to the property. They then reported back through their supervisor that the houses were safe. Where a 'no admit' was experienced, the service was cut off outside. Once satisfied all services in the sector were turned off, the town gas valves to the sector were closed and purging points at the perimeter of the sector were opened to atmosphere. Then the main valve controlling the natural gas was turned on and the town gas was purged from the system by the natural gas. Tests were carried out at each purging point with an instrument that indicated the presence of town gas. As soon as the reading was negative, the purge-point was closed, and this procedure was repeated at each of the other points around the perimeter. This operation was normally completed by 10.30am. (Rhodes 1966).

From 8:30am onwards, the fitter would return to the properties in order of priority and ensure each had the correct conversion kits. They then air tested the internal gas installation to 20" water gauge pressure (0.049 bar), fitted a filter and governor and changed the meter if required before converting the cooker. Any appliance not converted would be disconnected, labelled and, if required, removed to the workshop for converting. Fitters would then purge the gas installation, light and adjust the cooker and inform the customer about the changes. This process was repeated at the next address until about 6:30pm and on subsequent days until the sector had been completely converted (Rhodes 1966, Anon 1966c).

The residents of Canvey Island did not support conversion unanimously. Younger members of the population were in favour of conversion, especially if it meant they could obtain new appliances under special terms at a reduced cost. A fifth of the population, who were pensioners, were reluctant, claiming to be happy with their existing appliances and gas, although they were pleased to be informed natural gas was non-toxic. Ultimately, the most persuasive argument in favour of conversion was the cost reduction of 1 penny per therm (1 therm = 105 Megajoules) and the fact that all the costs were borne by the NTGB. Even at this point, it was evident the Gas Boards would be the major benefactors of conversion, as only half the volume of natural gas was needed to produce the equivalent heat content of town gas. That meant that any pipeline system immediately had twice the capacity to distribute gas (*Link Up* 1966).

The Canvey Island Conversion Pilot started on 23rd May 1966. Its team of 250 fitters was known to be excessive, but it allowed for any unforeseen issues to be resolved quickly. Splitting the Island into 24 sectors of 300-400 customers allowed the engineers time to improve the efficiency of the programme. At the outset, they worked in two three-day cycles of conversion with another two days set aside to resolve any outstanding issues. By the end of the programme, which was completed by 6th of August 1966, this had been adjusted to three two-day cycles with only one day to rectify faults. In all, around 1,200 conversions were undertaken each week. Costs were higher than expected, coming in at between £32 and £40 per customer rather than the £25 anticipated, but with the knowledge gained from the exercise, efficiencies could be realised in future (Rhodes 1966, Anon 1977b, Elliot 1980).

Crucially, the exercise provided an understanding of the logistical issues that would be encountered, which appliances could be converted *in-situ*, which needed to be taken to the mobile conversion unit or conversion base and which needed to be replaced (*Link Up* 1966). While much was learned and used in the rest of the conversion programme, factors such as the higher-than-average proportion of older residents and central heating and lower-than-average number of commercial and industrial customers had the potential to skew the learnings. These differences needed to be factored in later when considering other conversions (Elliot 1980).

While the Canvey Island pilot showed conversion was feasible both technically and administratively, it was not an unmitigated success, with the Consumers Association complaining that "*This pilot operation can be thought of as a success only if, in future conversion, the gas boards are able to eliminate the many problems that arose*."

This showed the importance of good public relations from the outset. The NTGB invested much in meetings with the local council, police, and various stakeholder groups, with much use made of the local gas showroom for demonstrations and displays. Although the cost reduction of gas may have been the main factor in keeping customers happy, the trial showed just what an integral part of the whole programme public relations would be (Elliot 1980).

This trial became the basis of the future textbook of conversion in Great Britain. It also formed the basis for the wider conversion programme developed by the NTGB, the planning for which was developed in 1968 for its start in April 1969 (Anon 1977a, Anon 1977b, Elliot 1980).

The cost of converting appliances in 1966 had been estimated at £400 million (equivalent to £6.1 billion today using the bank of England inflation calculator), with an additional £110 million (equivalent to £1.6 billion today) which was earmarked for a 1,300-mile gas transmission pipeline to distribute gas to the regions (Thames Gas 1966b).

As the North Sea gas resources were being discovered, there had been plans to construct major underground gas storage facilities to stockpile gas during the summer to cope with the increased demand for heating in the winter months. These never materialised due to the vast North Sea gas resources discovered and Liquified Natural Storage facilities were built instead at key locations in the gas network to provide short term storage. This included additional storage at the Canvey Island terminal (Thames Gas 1966b).

4. Planning for conversion

4.1 The establishment of the Conversion Executive and restructuring of the Gas Council.

The discovery of the Slochteren gas field near Groningen in the Netherlands had changed mindsets with the hope it could be replicated in Britain. As a result, the British gas industry had been planning on a total or partial conversion to natural gas.

During the first half of 1966, a working party was established under Arthur Hetherington (later Sir Arthur), who was at the time the Chairman of the East Midlands Gas Board (EMGB), to look at the complexities of such a conversion programme. Its remit would cover the impacts of high-level coordination, the technical and administrative complexities, and the benefits it would bring. It would also look at the challenge of retaining flexibility and devolving responsibility within the regional gas boards to enable them to carry out conversion efficiently. It was soon realised a working party was insufficient for such a mammoth task and that an official body was needed (Elliot 1980).

Two different organisations were formed. The first was the Conversion Committee, which had representatives from all regional gas boards and the Gas Council, was launched in the winter of 1966/67 and remained active until 1976. The second was a special Gas Council department, which became known as the Conversion Executive and was officially formed after a meeting of the Gas Council on 1st December 1966 (Smith 1977, Elliot 1980). The Conversion Executive had the following responsibilities:

- To review individual gas boards' conversion plans and assist the Gas Council in formulating a coordinated national programme for the use of natural gas.
- To determine the national requirements for appliances, conversion sets and associated equipment and ensure adequate production facilities existed to meet demand in accordance with an agreed conversion programme.
- To provide a channel of communication between regional gas boards and the Gas Council and make recommendations to the Gas Council on matters that needed national coordination.

Desmond Ellis, the former deputy director at Watson House, was appointed manager of the Conversion Executive, which first met in December 1966. Despite the formation of these two organisations, how to coordinate the conversion was not straight forward within the structure of the gas industry at the time. Great Britain was split into 12 regional gas boards (See Figure 3.1) that were largely autonomous, with the board Chairman very powerful. The Gas Council was essentially placed between the responsible government minister and the regional gas boards. With a statutory role 'to promote and assist the efficient exercise and performance by regional gas boards of their functions', it was not established to lead conversion and was not structured for this purpose either (Elliot 1980).

Consultants McKinsey and Co. were employed to undertake a major investigation of what changes were required at the Gas Council to make it fit for the purpose of conversion. The main findings of the report led to the creation of three major separate divisions within the Gas Council:

- Production and Supply Division, for the acquisition, transmission and distribution of the new supplies and coordination of engineering generally.
- Economic Planning Division, taking responsibility for the overall planning of the new industry including its finance.
- The Marketing Division, which covered all customer activities including domestic, commercial and industrial gas sales, customer services, conversion, marketing publicity and home service.

The reform of the Gas Council also had a significant impact on the regional gas boards. They had to cede some autonomy to the Gas Council in the creation of these new divisions, which was only possible with the cooperation of the powerful Board Chairman. Heading the three divisions were Denis Rooke (later Sir), responsible for Production and Supply, James Buckley, responsible for Marketing, and finally Ernest Mills, responsible for Economic Planning. All were in place by the Spring of 1968 (Ellis 1980) and this structure had to suffice until the formation of the British Gas Corporation on 1st January 1973 following the Gas Act of 1972 (Elliot 1980).

Of the three divisions, Marketing was most actively engaged in the conversion process. It first established a Marketing Policy Committee composed of senior marketing executives from each regional gas board. The Conversion Executive was also transferred to the Marketing Division due to its close integration with other customer functions and to receive support from them. The Marketing Division also developed strong links with appliance manufacturers by strengthening the Joint Consultative Committee with the Society of British Gas Industries, the manufacturers' trade association. Representative committees focused on domestic, commercial, and industrial gas sales were formed along with a one that looked at service, conversion and appliance standards (Elliot 1980).

Desmond Ellis's Role expanded to include customer service within the Marketing Division as well as his role managing the Conversion Executive. Ellis was key to the whole conversion programme. As well as his knowledge of appliances, he brought with him a military style of management from his involvement with the Territorial Army. He had a focus on organisation and the insistence of papers, reports, and records along with high personal standards he expected from his team.

Not only did he work hard to get to know the people he worked with, holding regular meetings on and off site, but he was also anxious to ensure close cooperation between the regional gas boards and the Gas Council. He worked hard to ensure the Conversion Executive did not become isolated in the Gas Council and to second staff who could help the programme. One such secondment was Alan Sharpe, who transferred from the Gas Council Public Relations Office to the Conversion Executive for two months. This short secondment built a lasting long-term relationship that greatly aided the success of the conversion (Elliot 1980).

Ellis recruited a highly able team to support him, including marketing specialist Brian Healy as his deputy. In charge of planning, Ellis recruited Arthur Andrews, with whom he had worked at the NTGB, and knew to be an excellent administrator capable in the use of computers, which would play an important role in the conversion. Ellis also brought in Don Cooper from the SoGB to develop the purchasing programme, which eventually led to the creation of the British Gas Purchasing Department that operated long after conversion was complete (Elliot 1980).

Ellis worked on a long-term vision for the programme, which even considered the issue of its run down some eight years later, believing it was better to be prepared upfront than make last-minute decisions in haste closer to the time. His team carefully considered cost control and looked to maximise savings, undertaking comparative studies from the different regional gas boards from early in the programme to see where savings could be made (Elliot 1980).

The Technical Section of the Conversion Executive made a careful study of other conversion programmes that had happened in Great Britain and realised the technical challenges would be considerable. To benefit from the learning of those gas boards that had already embarked on conversion, the section set up a hot line between itself and the boards. This was later formalised into a Technical Advisory Panel between the regional gas boards, Watson House and the Gas Council, which met monthly and was Chaired by Frank Webb, a Senior Technical Officer in the Conversion Executive. It proved the ideal platform to exchange information on problems and corrective actions and led to a Watson House Report ‘Regions Technical Problems on Conversion’ (Wilson 1974, Elliot 1980).

The Technical Section carried out special exercises between the summer of 1969 and winter of 1970, which identified approximately 70,000 faults, the breakdown of which is shown below (Elliot 1980).

Further analysis of cookers and heaters (Figure 4.1) showed basic models that were assumed easy to convert represented faults in 25% of cookers and 39% of water heaters. This observation resulted in teams being dispatched to the regions to observe the issues first hand and find practical resolutions, including:

- Improving converters' training, especially in relation to burner adjustment.
- Redesigning and modifying some conversion sets and fitting instructions.
- Improving quality control.
- Enhancing customer relations and giving customers better education in how to use the new gas.

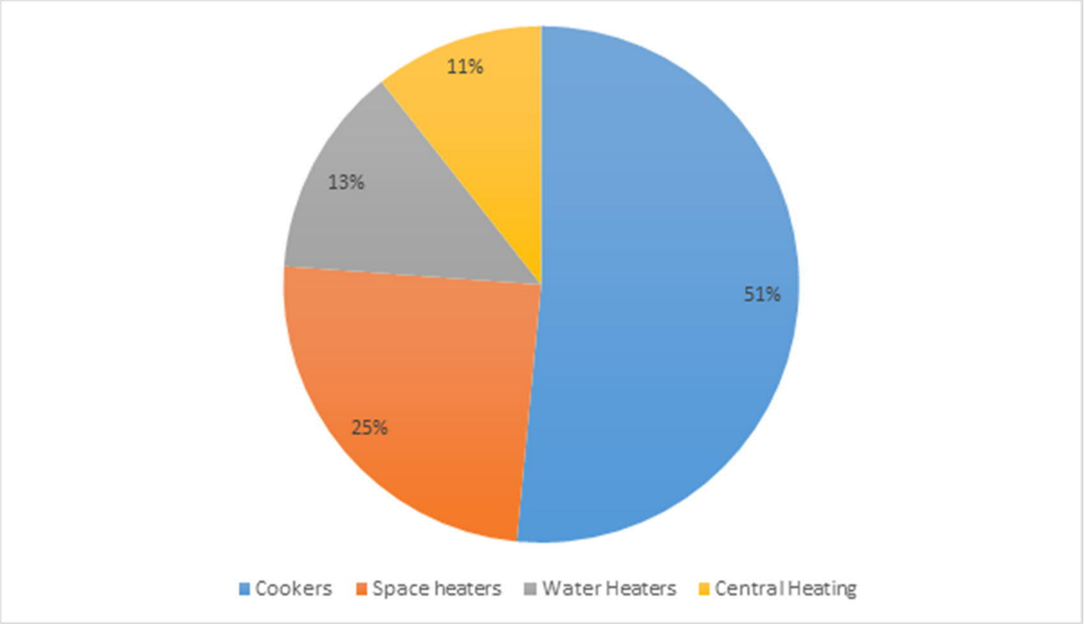


Figure 4.1. Percentage of call back faults found in approximately 70,000 different appliances converted between 1969-70.

The identification of these faults enabled manufacturers to produce a new phase of conversion sets. Where large numbers of the faulty older sets were in stock, the faulty parts could be replaced to upgrade the conversion sets (Elliot 1980).

Quality control checks were undertaken at the appliance manufacturers and within the regional stores. If issues related to poor manufacture, poor quality or faulty packaging, it was dealt with by the Watson House Production Standards Group. Each engineer within the group was responsible for about 25 manufacturers who were visited regularly. They investigated the defects and ensured action was taken to correct them. (Byford *et al* 1977).

The Purchasing Section played the vital role from the start, as the economic viability of the programme depended on stringent cost control. They developed 'standard cost statement and accounting instructions', which were observed by all gas boards from 1st October 1968 and set out which costs could be charged to conversion rather than other activities. This was produced every three months as a basis for management to control costs (Elliot 1980).

The cost of converting appliances in 1966 had been estimated at £400 million (in 1966 terms), with an additional £110 million earmarked for a 1,300-mile gas transmission pipeline to distribute gas to the regions. If the alternative route of reforming natural gas to town gas had been followed, the costs involved in providing and operating reforming plant and adding sufficient pipelines and storage plant to the existing distribution system to meet the increased demand would have cost more than £2 billion (in 1966 terms, equivalent to £30.8 billion today, using the Bank of England inflation calculator). This was far in excess of the cost of conversion and proved the economic case (Thames Gas 1966b, Elliot 1980).

4.2 The role of research in the conversion process

Watson House, the Gas Council's London-based research, development, and testing centre for domestic appliances, was active from the start. It was researching the burning of high calorific value gases including natural gas in 1961, five years before the conversion decision had been made. More focused research on natural gas use began in 1963, some of which had been undertaken in association with appliance manufacturers (Elliot 1980).

Researchers assessed the required modifications to domestic appliances and how their design would need to evolve in the future (Elliot 1980). Watson House research centre, led by its Director Clifford Purkis, provided support on domestic appliances whereas the Midland Research Station in Solihull, led by Dr W. Simmonds, provided support for the industrial sector. (Elliot 1980).

Teams from Watson House had visited several countries abroad, including France, the Netherlands, USA and Canada, to collect information and observe methods and organisation for conversion (Byford *et al* 1977, Anon 1969). Watson House were not the only ones to learn from contractors working abroad. A team of gas engineers from the WMGB flew out to Lübeck in West Germany to observe Dutch contractors undertaking the conversion of the gas network from town gas to natural gas (Boost 1976).

All this prior research proved vital in enabling the Canvey Island conversion to proceed, as the time available between the decision in the Autumn of 1965 and the date start June 1966 was extremely short (Rhodes 1966).

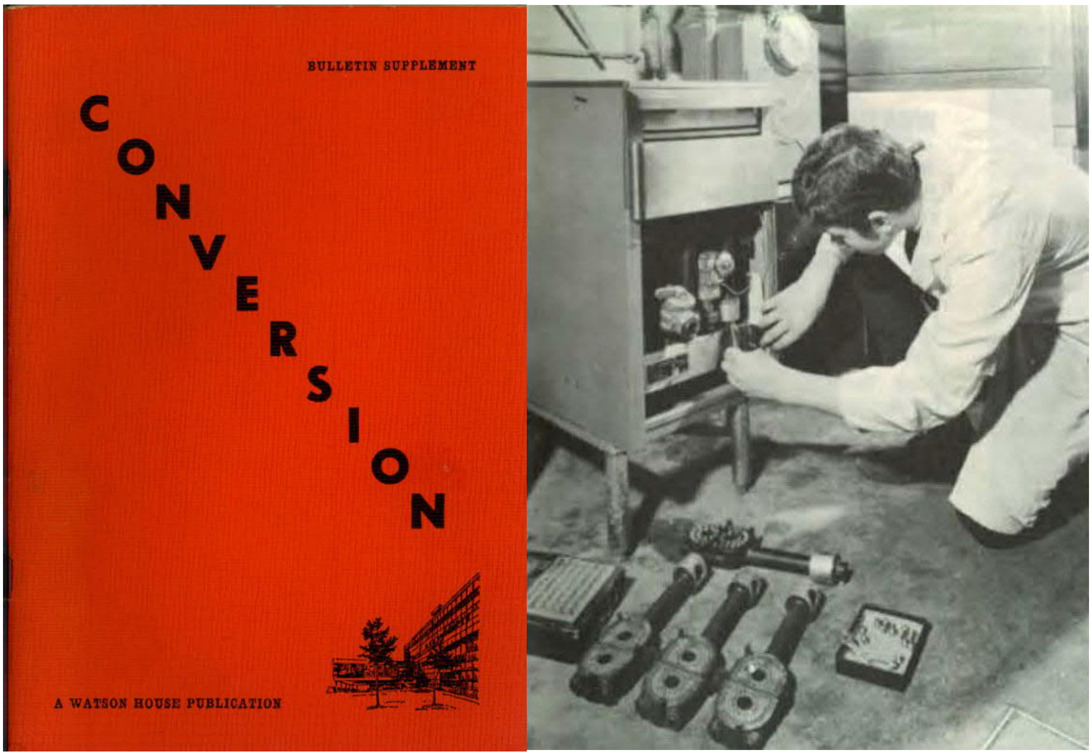


Figure 4.2 The Conversion booklet produced by Watson House (left) and a Watson House Engineer checking the ease of conversion of a small gas fryer (right). Source - National Gas Archive.

During the Canvey Island conversion, Watson House tested and approved the conversion kits produced by manufacturers. It also had a key role in devising conversion strategies for older appliances, especially where the manufacturer had ceased trading (Elliot 1980). Throughout the main conversion programme, Watson House provided support to ensure a foolproof method for the correct identification of appliances and provided support to make it easier to predict which models would be encountered in sufficient numbers to make ordering conversion kits worthwhile (Elliot 1980).

Watson House prepared standards for conversion and for new bi-gas appliances and dealt with the detailed planning necessary for the approval of conversion sets for existing appliances and new hybrid ones. It prepared appliance identification manuals and allocated unique seven-digit numbers to every appliance model it identified (Byford *et al* 1977).

By the late summer of 1966, Watson House had switched all its available resources to working on natural gas. Fundamental research was channelled into establishing basic data concerning the burning of natural gas. Development effort was concentrated upon the principles of appliance conversion and design to burn both town gas and natural gas to help manufacturers develop conversion sets and design new appliances. Watson House had developed a Gas Quality Laboratory before conversion for testing different town gases and, as conversion approached, this was adapted to include natural gas (Byford *et al* 1977).

Watson House also played a vital role alongside the Gas Council in producing a series of conversion manuals for domestic and non-domestic appliances (Hindmarsh 1970). By the Autumn of 1967, around 8,000 separate models had been identified and listed in the 'Watson House Identification Manual'. Each page included the manufacturer's name, the name of the appliance and its model number, the position of the data badge and general information such as height, width, depth, finish and any other relevant details for recognition purposes. Any known varieties of the appliance, or different names for similar appliances, were also recorded. Finally, each identified appliance was given a seven-figure Gas Council identification number. This information was also provided in a Pocketbook for the fitters (Gas Council 1969, Byford *et a*l 1977, Elliot 1980). In early 1970, Watson House also developed the pocket-sized mini purge test burner to help converters tell when an appliance was 'natural gas ready' (Wilson 1976).

Under the supervision of the Test Gas Study Group, Watson House undertook the task of formulating the standards for natural gas-burning appliances in collaboration with several industry bodies, including the Society of British Gas Industries (SBGI), the Catering Equipment Manufacturers' Association, (CEMA) and the National Association of Restaurant Engineers (NARE). A vast range of appliances would be included, and no single standard was suitable, so they were split according to whether they were non-current, currently approved and new. They were also categorised as domestic, catering or commercial (Byford 1977).

The Midlands Research Station spent considerable time studying the burning of natural gas in industrial burners and published its research in 1967, ahead of the main conversion programme. This provided the general solutions to conversion of existing burners. Each regional gas board also had an Industrial Development Laboratory whose role it was to apply these general principles to the large range and variety of existing burners (Gas Council 1969).

The North Thames Gas Board (NGTB) used its Stove Works, located on Harwood Terrace in Fulham, to develop and test domestic appliances and its Industrial Laboratory, located in the Bromley Gasworks, tested large non-domestic and industrial appliances as part of the Canvey Island pilot conversion (Anon 1966c).

The Industrial Development Laboratory of the NTGB at Fulham constructed a display table of burners, which consisted of two rows of comparative burners, one being town gas burners and the other their converted equivalent. It showed that, on some unmodified town gas burners operating on natural gas, lift-off conditions would occur. This display proved an invaluable visual aid to demonstrate basic principles to a gas board's conversion staff, customers, manufacturers, and contractors (Gas Council 1969).

Leslie. W. Andrew, Director of Watson House, stated on 5th March 1969 that "*the complexity and speed of the conversion of appliances to burn natural gas was greater in Britain than in any other gas industry in the world*." He went on to say that "*Britain has the highest density of appliances in the world, the variety of appliances developed to meet the customers' wishes is wider than anywhere else and the quality of appliances, designed to produce the best results, has advanced so rapidly that tolerances have become more critical. Many of the problems are, therefore, set by the industry's own success*." He believed the studies undertaken on conversion practices in other countries combined with research and development carried out by the British gas industry meant "*Britain is now recognised as one of the world's authorities on the conversion of appliances*." (Elliot 1980).

The role of research was not limited to appliances. It was required to understand the consequences of conversion on the gas network and enable the construction of the National Gas Transmission System.

Switching from a wet town gas to a dry North Sea gas had a significant impact on the mains network and researchers played a significant role in overcoming the associated challenges. One example was solving the issue of leaking gas mains. The mains included around 24 million jute-sealed joints. Jute swelled due to the damp town gas to seal the joints, but they leaked under the dry conditions of natural gas. (BG Technology 1993).

To solve this, some regional gas boards had introduced steam to maintain the previous level of water vapour, a practice known as humidification, but a cheaper and more practical solution was required. The Gas Council Engineering Research Station (ERS) at Newcastle investigated using different swelling agents and identified as the solution monoethylene glycol (MEG), which swelled jute and a high vapour pressure that allowed it to travel more extensively in the gas network. (BG Technology 1993).

Natural gas also caused issues for the rubber joints on the network, of which there were some 15 million at the time of conversion. The natural gas lacked the oily compounds that kept the rubber joints supple, so a similar approach was developed by ERS, LRS and the NWGB, this time using oil fogging. The process was introduced into affected areas in 1974, shortly before MEG fogging began. The ERS researchers work meant the team also developed considerable expertise in leak detection (BG Technology 1993).

Britain adopted US-style large diameter cross-country steel pipeline construction methods and existing American Petroleum Institute specifications. This was, however, not directly transferable because of different line-pipe steels and construction practices used in Britain. ERS assembled a team of welding and non-destructive testing specialists and became the in-house experts to solve problems as they arose (BG Technology 1993).

The ERS also took a prominent role in the development of plastic pipes for use in the gas network. PVC pipes had been trialled from the 1950s for gas distribution but were unsuccessful because some elements of town gas damaged the pipes. Starting in 1967, under the supervision of Gerry Clearhough, (Manager of the Plastic Project Group) the ERS undertook extensive testing of polythene pipes, including setting up laboratory facilities to study the behaviour of the material with gases in use at the time. The success of the research led to the development of the ISO and CEN Industry standards for polyethylene gas pipe systems. ERS also researched and developed pipe jointing systems for polyethylene pipelines, which were to become a major part of the gas network (BG Technology 1993).

4.3 Conversion strategy and regional planning process

Although the regional gas boards had been working in isolation for the 20 years after nationalisation, a different approach was promoted with the conversion. Inter-regional contact was actively encouraged, as was communication between headquarters and regional departments as part of a deliberate policy to break down regional autonomy, which would have hampered conversion. Barriers between different departments at the

regional level were also quickly demolished as cooperation was required across almost all regional functions to enable conversion to proceed (Smith 1977).
Lessons learned from the experience at Canvey Island were then fed into the regional planning process. Each regional gas board had to devise its own seven- or eight-year strategy to enable conversion, with some flexibility built in. In devising a conversion strategy for a regional gas board, the following points needed to be considered (Byford *et al* 1977, Smith 1977, Elliot 1980):

- Overall availability of natural gas. Regional gas boards were supplied by off-takes of the National Gas Transmission System (NGTS). Initially, this was eight regional gas boards receiving off-takes from National Methane Pipeline, but once the NGTS started feeding in North Sea gas supplies, additional 'feeder' pipelines were built to supply gas from the North Sea Import Terminals at Easington and Bacton.
- Prioritisation of the existing distribution network area, where existing supplies and/or pressures were becoming inadequate.
- Prioritisation of areas with increasing demand for gas that would have required either costly construction of new gas-making plant or gas mains reinforcements.
- Early phasing out of obsolescent and less economic manufacturing plants.
- The location of town gas production stations and the necessity to maintain adequate town gas storage.
- Consideration of existing gas supply contracts, e.g. mine drainage gas, coke oven gas, etc.
- Early conversion of industrial areas to secure new premium loads on natural gas, often taking industrial users from other fuels as well as town gas.

The detailed planning of the distribution system strategy and sectorisation was carried out at a regional level using the regional gas board workforce and supplemented with contractors where appropriate (Richardson 1977).

While feeding natural gas progressively through Canvey Island had proved a simple process, in any larger operation it was expected to be much more complex. Network analysis was extremely valuable in determining the feasibility of introducing gas through a larger area. Experience elsewhere suggested a great deal of distribution system information could be obtained from such analysis and was of great value, quite apart from the benefit for conversion. It had been practised more widely in mainland Europe, where it was found necessary to allow at least 12 months for this work to be done before conversion. The detailed investigation of the gas network by distribution engineers, using network analysis, allowed the industry to determine the exact location for all mains, valves and services (Rhodes 1966, Elliot 1980).

The aim was then to create balanced sectors for the future conversion teams to work on, initially based on the number of customers but later changed to the number and type of appliances. Sectors also had to consider the number of commercial and industrial customers, which would be converted by different teams, and the need to provide a balanced workload for these teams (Elliot 1980).

The pace at which a sector could be converted was based on the length of the conversion cycle. Two different approaches were adopted – a two/three-day cycle and a five-day cycle. The latter was general regarded as the five-day working week, with additional time at the weekend if required, and enabled pre-conversion work at the weekend for the commercial and industrial conversion team. This approach was thought to be cheaper, more flexible, and better able to absorb peak loads and call back. However, it did expose the customer to longer periods of disruption and more limited use of appliances. The two/three-day cycle caused less disruption but was also less flexible. Nevertheless, it was adopted by the NTGB and NEGB, with all the other boards adopting the five-day cycle.

Each regional gas board created a new Conversion Department responsible for rolling out conversion and working closely with other departments to ensure it went smoothly (Hindmarsh 1970). All regional conversion departments operated formal liaison arrangements with the following operational functions (Smith 1977):

- Distribution: responsible for initial sectorisation, sector proving and purging, service cut-offs and leakage surveys before and after natural gas turn-in.
- Purchasing and stores: procurement of conversion sets, ancillary equipment and spare parts together with maintenance of optimum stock-holding levels.
- Transport: delivery of conversion sets and the periodic moving of conversion site vehicles.
- Public relations: making the path of conversion a smoother one, before, during and after.
- Sales: negotiating the replacement of many old and difficult appliances with those easy to convert or not requiring conversion.
- Home services: a support function to PR in general and providing practical solutions to customer problems in the immediate post-conversion phase.
- Customer service: the precise duties of the service function varied depending on the extent of contractor involvement. In many regions these departments administered and undertook preliminary work, updated customer appliance files between survey and conversion and upgraded ventilation and substandard installations. At or immediately before conversion, sell-out and washed down (replacement) appliances were fitted. Customer service department

representatives attended reported gas escapes and dealt with any additional preliminary work found not to have been done. They were also involved in the call back period, but mainly after the conversion teams moved out.

Once the programme had been approved by the Gas Council, the entire conversion planning sequence was put into action (Byford *et al* 1977, Elliot 1980). Except for conveniently situated industrial estates, early conversions tended to concentrate on predominantly rural or suburban localities, which were less densely populated and thought to be an easier starting point. However, these areas often included customers who were particularly sensitive to the inconvenience conversion caused (Smith 1977).

4.4 Regional trials – Burton on Trent, Withernsea, and Mossley and Saddleworth

Burton on Trent was the next area to be converted, starting on 15th May 1967 in the outlying village of Alrewas. It was the first town of any size to be converted and took until the end of the year to complete. More than 25,000 customers were converted in total at an initial rate of 500 customers per week, but using a three-day cycle, this had increased to 1000 a week by the end of the programme (Byford *et al* 1977, Elliot 1980).

Burton on Trent used a relatively small sector size of 250 customers and started off in the wealthier suburbs, where between 30% to 40% of customers had gas central heating as well as other gas appliances. Given the weather was relatively cold and wet at the time of conversion, there was pressure to convert them on the first day. This experience showed it was the number of appliances rather than the number of customers that was the critical for defining the size of a sector (Elliot 1980).

During the first few weeks of the Burton on Trent conversion exercise, the gas supplied was Algerian methane fed from Canvey Island through the NGTS. This later switched to gas from the West Sole gas field in the North Sea, brought to shore at the Easington Terminal and transferred via the new feeder transmission line to the NGTS. The substitution of the gases caused no significant effect, with appliances working fine on both gases despite their slight difference in calorific value (Elliot 1980).
The first surveys undertaken on customers gas appliances were very accurate with only 1% of the conversion sets incorrectly delivered. There were a few instances where appliances had not been included in surveys, these cases were almost entirely due to portable gas appliances being in storage at the time of the survey. (Elliot 1980). These types of portable appliances using mains gas would not be encountered today.

The trial identified concerns over the quality of the conversion sets provided by the manufacturers, which occasionally had missing or incorrect parts and incorrectly sized injectors. As a result, another quality control step was introduced along with regular checks at manufacturers' works (Byford et al 1977). This would help identify issues well before the sets were used and avoid delays on conversion day (Elliot 1980).

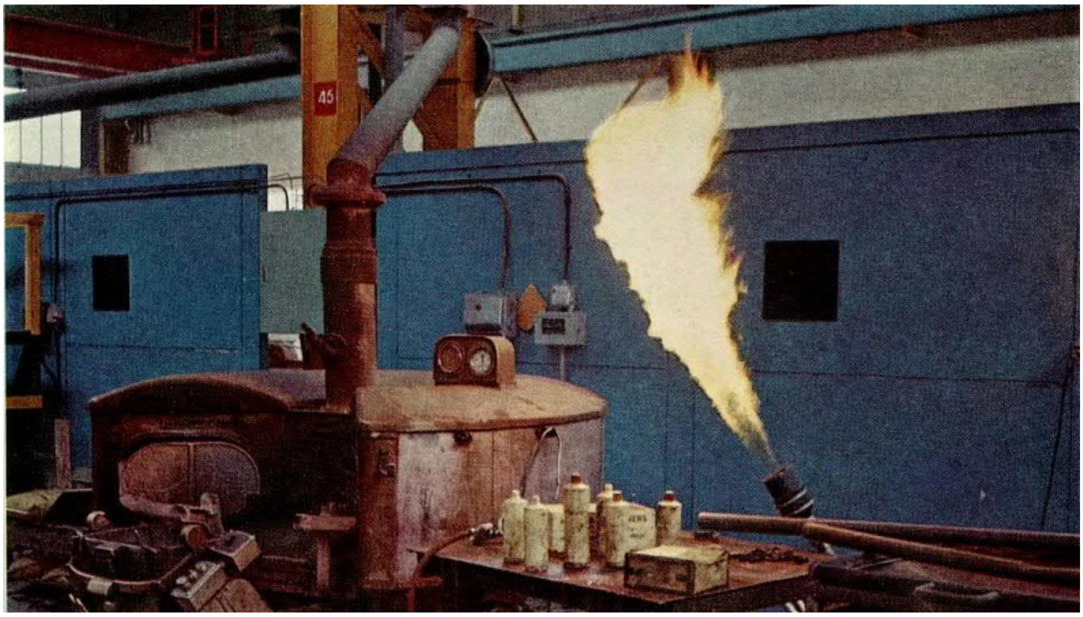


Figure 4.3 Flaring Gas during the conversion of Lloyds Factory at Burton on Trent. Source - National Gas Archive.

As with the Canvey Island trial, old and obsolete appliances were identified and had to be taken to a workshop for conversion. Prior concerns in Burton on Trent over access to premises was also unfounded, with fewer than 2% being inaccessible and just over 1,000 having their supply cut off. (Elliot 1980).

Public reaction to the Burton on Trent trial was mixed. Call back rates were around 20% and media coverage included some scare stories. The first 5,000 customers were polled by the EMGB and while three quarters were happy with their conversion, around a fifth expressed dissatisfaction with some aspect. Some customers found natural gas harder to use, whereas others found it to be cleaner and more efficient. The mass servicing of appliances during conversion improved the performance of many appliances, increasing efficacy and safety (Elliot 1980).

The EMGB went on to complete other conversions in the Swadlincote and Wellingborough districts before the main programme started in April 1968 (Ellis and Aspinwall 1968).

A Gas Council working party had suggested each regional gas board put forward a town or district for conversion during the year 1967-68. This had to be revised as concerns over the security of supply of LNG from Algeria and the required extensions of the NGTS made it unfeasible to undertake such early conversions in the ScGB, NGB, WGB and SWGB.

The Northeastern Gas Board (NEGB) had created a new Conversion Department under the command of Bryan C. Smith in late 1966. NEGB had planned a larger conversion to start in their East Coast Group in September 1967. This was eventually limited to a smaller conversion in the Withernsea area of about 2400 customers due to disruption to Algerian methane supplies. This small trial conversion proved highly useful training for NEGB. The conversion team had the benefit of visiting the Burton on Trent conversion and had also worked with Watson House on the ad hoc conversion of appliances that did not have a bespoke conversion set and on the conversion of commercial appliances (Wilson 1974).

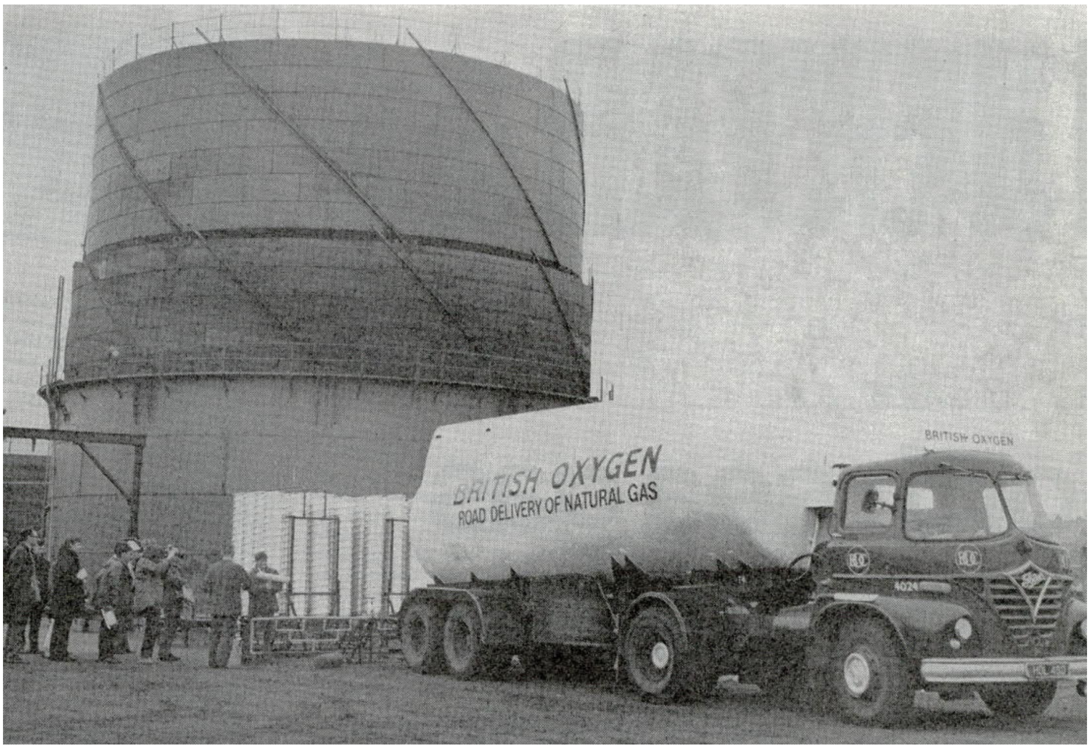


Figure 4.4 Unloading a delivery of LNG to fill one of the Withernsea's gasholders during conversion. Source - National Gas Archive.

The NEGB started the conversion of Withernsea at 8am on 26th September 1967. Withernsea had been divided into eight sectors, which contained 1,338 premises in total. The first sector contained 109 premises. Each sector was allocated two days for completion, the first day being used for the conversion of non-essential appliances and the second day for essential appliances and the introduction of natural gas. (The Yorker 1967).

The Withernsea conversion was undertaken by four domestic conversion teams and one commercial conversion team, the conversion engineers had received four weeks special training before conversion started. The NEGAS technical unit accompanied the conversion team to Withernsea to provide technical support. A mobile workshop and a control unit were based in Withernsea, whilst a main stores and workshop were provided from the Bridlington works (Wilson 1974).

Conversion procedures for the twelve most common obsolete appliances (also referred to as ‘Main Runners’) known to be present in Withernsea were available to the conversion engineers. For appliances which did not have conversion kits available, they were either converted in the mobile workshop or in more difficult cases taken to the main conversion workshop (Wilson 1974).

Their first action was to switch off the gas at each house in the sector. Each group of converters was coordinated by a foreman who kept in constant radio communication with the control officer based in the mobile command vehicle. Once the conversions were complete, a signal was passed to ‘Turn-In’ natural gas into the sector. The conversion fitters would then open the stop cocks on the gas supply to allow the conversion and testing of appliances to begin. They converted cookers first before other essential appliances. In the days following conversion, a home service advisor would visit each customer to help with any queries regarding natural gas (The Yorker 1967).

The conversion included the local hospital and the commercial conversion team had to develop procedures for its appliances (Wilson 1974). At the time of conversion, the natural gas used was Algerian LNG, which had been transported by road tanker from Canvey Island LNG Terminal and used to fill one of the gasholders in the town (Figure 4.4). The other gasholder still contained town gas supplying non-converted sectors because Withernsea only had one gas main and that was needed to supply town gas until conversion was complete (The Yorker 1967).

The conversion of Withernsea took four weeks to complete, with two weeks of post-conversion issue resolution. The team learned a great deal while on the job and tripled the number of written conversion procedures during it from 12 to 36. As the conversion was paused by disruption to Algerian LNG supplies, the team used the delay to study

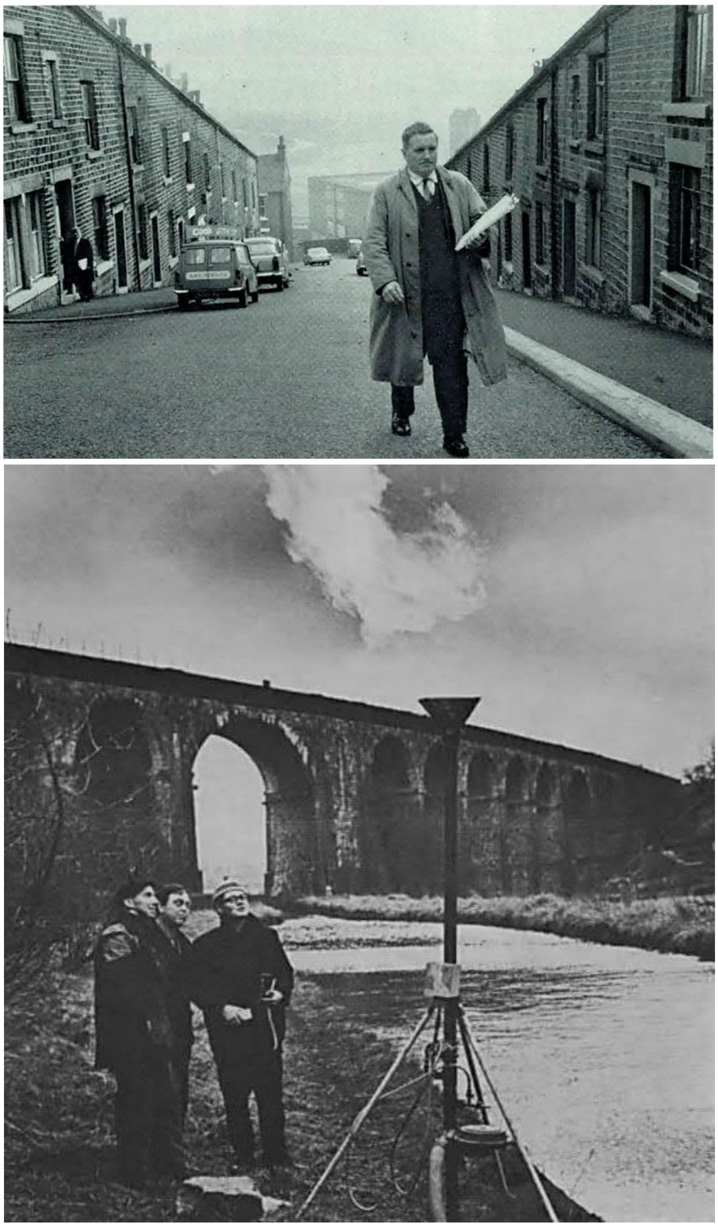


Figure 4.4 Undertaking the Survey Mossley (top) and Burning off gas at Saddleworth 1968 (bottom). Source - National Gas Archive.

each conversion and document the learning in a report. The hold-up also provided enough time to convert several factories in Leeds that had been next to the NGTS in Leeds and thereby improve learning about industrial conversion. NEGAS developed an important innovation during this time, a special range of injection adaptors for commercial equipment called N.E.Daptors that made the conversion of some commercial appliances much quicker. These were manufactured by Adaptogas, which eventually manufactured around two million of these fittings.

Figure 4.5. The mobile store being stocked by John Broadbent.

Following the pause, the east coast conversion started up again in March 1968 at Hornsea (Wilson 1974). The remaining NEGB Area was estimated to take a further 7-10 years to convert its 800,000 customers (The Yorker 1967).

The North Western Gas Board (NWGB) undertook its first trial in Mossley and Saddleworth on the Yorkshire-Lancashire border. The trans-Pennine section of the National Methane Pipeline was nearby and a 14-inch spur pipeline to the Bradford Road Gasworks in Manchester passed through the area. The Conversion unit was headed by

Don Wilson. The initial pre-conversion work which included the replacement of meters where required and the addition of a filter and governor was undertaken in October 1967. The new meters and governors being provided from a mobile store (Figure 4.5). The surveys for and Saddleworth took 3 weeks during November 1967, with the actual conversion process starting on the 18th of March 1968, with only 2,000 customers converted before the proposed April start date of the main programme.

The North West Gas Board needed a second much larger 36-inch transmission pipeline to be constructed as part of the NGTS to be built from the Midlands to Partington in Cheshire to enable conversion to proceed. Partington was, the site of a large gasworks which supplied Manchester and the wider area (Elliot 1980).
The total number of conversions undertaken nationally by 31st March 1968 (Including Canvey Island) was just over 50,000. All other conversions were undertaken within the timescale of the main programme. (Elliot 1980)

5. The main programme begins

The main programme began in April 1968. Most regional gas boards were supposed to have undertaken pilot trials beforehand, but only NTGB, EMGB and NEGB achieved this. Those that had not carried out such a pilot started their conversions with a demonstration project, located near their supply of natural gas taken from the growing NGTS. For example, the West Midlands undertook its demonstration project at Coleshill, next to the off take from the National Methane Pipeline (Elliot 1980).

Well before the main programme started, regional boards and headquarters set up their organisational and communications structures. Regional boards also established their operational procedures in detail, backed up by learning from a series of visits to European and North American conversion areas (Smith 1977).

The Gas Council headquarters hosted preliminary meetings with representatives from each region to review regional plans and ensure a coordinated approach as well as to determine national conversion material and spare parts requirements (Smith 1977).

It was not until 1969 that the government signed off an agreement for public property on the existing gas network to be converted to natural gas (Smith 1977). The programme affected close to 14 million domestic dwellings and hundreds of thousands of commercial and industrial premises, spread out across 12 gas boards covering their own designated areas (Richardson 1977).

Conversion would inevitably result in the loss of many jobs in manufacturing. To alleviate this, the Gas Council produced a booklet ‘Changing to Natural Gas’, with the help of the Trade Unions and the regional gas boards, to supply employees with 'basic information and details relating to future employment in the natural gas industry’. (McCawley 1977).

5.1 Collaboration the key to success

Key to the success of the conversion process was collaboration between all the stakeholders involved, including the Gas Council, regional gas boards, Watson House (research station for domestic gas use), appliance manufacturers, contractors and converters. Close collaboration was required to ensure a smooth experience for customers and this was achieved through the central function of the Conversion Executive (Elliot 1980).

5.1.1 Contractors

Conversion was a huge task. It needed to be effective and viable while also allowing the main work of the gas industry to continue reasonably unaffected. The regional gas boards, in selecting contractors to provide almost all of the field labour force supplemented by technical and managerial resources, were able to satisfy these conditions. If the gas industry had attempted to recruit staff to cover all of the requirements of conversion, they would have had to make them redundant at the end of conversion. Using contractors more use to working on fixed-length contracts was seen as a better solution. Despite this, the SoGB and NEGB both decided to undertake conversion internally (Richardson 1977, Elliot 1980).

Both the boards and their contractors had platforms for discussion during the conversion process. For the industry, it was the Gas Council Conversion Executive, while for contractors it was the Gas Conversion Association, which emerged from the Society of British Gas Industries (SBGI) (Richardson 1977).

Where regional gas boards had a significant labour force and were supported by strong Trade Union representation, they carried out more of the direct labour operation internally than in areas where this was not the case (Richardson 1977).

Tasks such as: public relations and investigation, planning and sectorisation of the distribution system were typically carried out by the regional gas board. The fitting of filter governor units and meter inspection and replacement were also typically carried out by the regional gas board, but sometimes contracted out.

Similarly, domestic surveys in some regional gas boards were carried out by the conversion contractor, while in others these were done internally, though in each case the data was processed and analysed by regional gas board staff.

Except for the NEGB and SoGB, who used their own directly employed workforce for conversion, contractors were brought in to deliver much of the work. The method of contracting differed across the regional gas boards. Some included preliminary and pre-conversion work while others contracted out commercial and industrial conversion. In the main, contractors made up the bulk of the field workforce. At its peak, there were around 10,000 engineers, normally working in groups of 8-10 people for eight major contractors and two regional gas boards (Richardson 1977, Elliot 1980).

Each regional gas board which used contractors to undertake conversion, had to determine its own specific requirements and scope of work to be outsourced from their contractors. The contractors being appointed through a competitive tendering process, with either one or two contractors selected per regional gas board (Richardson 1977, Elliot 1980). Contractors would either put forward a lump sum contract based on price per appliance or a fee/reimbursable contract. The latter method generally required management and supervision to be included in the fee, which could be fixed or scalable, while the labour element became, broadly speaking, reimbursable.

Richardson (1977), who was the chairman of Anglo-French conversion contractor HGS, said the British gas conversion operation was far and away the largest and most sophisticated of its type. And unlike that of some countries, it placed great emphasis on consideration for the consumer.

5.1.2 Appliance manufacturers

In his paper 'The Role of the Domestic Appliance Manufacturer in Conversion', of the SBGI (Mr T. Counter), said: "The whole conversion operation will be judged not by the quality of offshore drilling or high-pressure main laying but by the quality of the conversion set." This reinforced the point that the performance of the gas in the appliance was the only aspect of the industry most customers would have the chance to observe and would affect their lives.

The rate of conversion had as much to do with the rate at which conversion kits or new natural gas-ready appliances could be manufactured as it had to do with the availability of natural gas. There had been a long-standing link between manufacturers and the gas industry, as gas appliances had typically been purchased from showrooms owned and operated by the regional gas boards. They had cooperated over the production of appliances and the industry's corporate structure provided the resources to stipulate and check product quality and undertake research and development into gas use and to improve appliances. Consequently, British gas appliances became unequalled in technical development and their range of application (Smith 1977).

These sophisticated appliances used non-aerated burners, automatic low voltage electric and flash tube/pilot type ignition for small movable appliances such as cookers and fires and wet and dry central heating units, the market for which was being expanded. It was precisely these sophisticated features that proved a challenge to modify at the time of conversion. Town gas had typically used non-aerated burners, while natural gas required the use of aerated burners, making it more complex to develop burners for both. It was envisaged that, when natural gas replaced town gas entirely, burners, ignition and control systems could be simplified for use with a single gas again (Culshaw and Prigg 1969, Smith 1977).

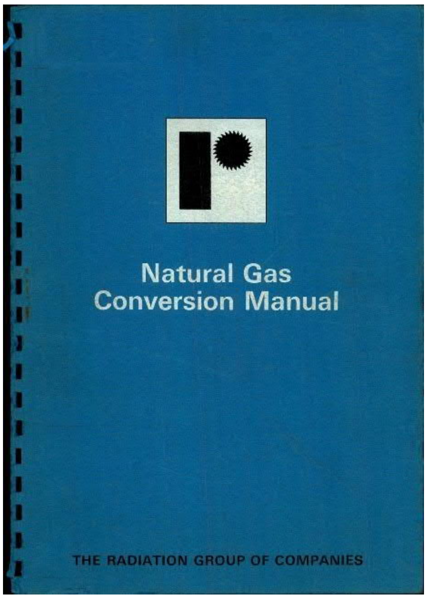
Customers had grown accustomed to the high standards of comfort and convenience provided by new appliances and would not tolerate the kind of long conversion cycles that had been a feature of conversions in other countries (Smith 1977).

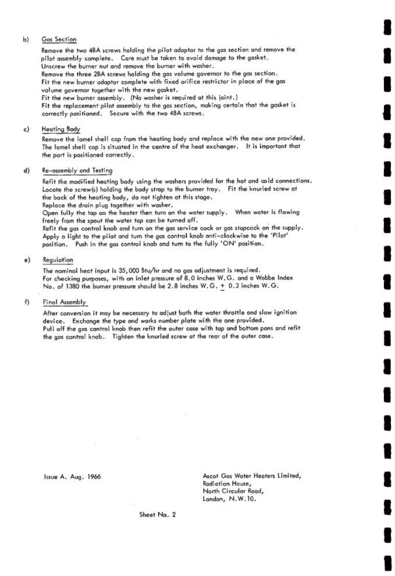
Toward the end of 1965, the NTGB approached manufacturers with an urgent request to supply conversion sets for gas appliances being converted to natural gas. These manufacturers worked alongside the NTGB and Watson House and gained valuable experience. This operation helped to establish: (a) areas where the greatest effort of laboratory development work was needed; (b) the principle that, while most appliances could be converted *in-situ,* some would need to be removed to a local workshop for conversion; and (c) that an large percentage of appliances were in a poor state of adjustment and many, particularly commercial appliances, would need complete renovation before they could be converted.

One manufacturer – Radiation – produced a conversion manual that was a complete record of conversion sets they supplied to the NTGB for the Canvey Island project. This included a separate sheet for each set showing a photograph of each appliance, a schedule and photograph of parts included in the set and full conversion and testing instructions (Figure 5.1). It was, in effect, the forerunner to the Watson House Conversion Manual.

Given the short time available, many of the kits were developed from Liquid Petroleum Gas (LPG) applications with lower port loading. This resulted in the of loss of certain capabilities such as automatic ignition. For the manufacturer, one of the biggest concerns was the avoidance of 'lift off' on appliances and how burners would have to be re-engineered to produce stable flames, which could be achieved using retaining flames (Barnes and Henshilwood 1967).

The centralised purchasing approach taken by the regional gas boards meant appliance manufacturers were effectively dealing with a single client requiring a high volume of goods over a relatively short period (Elliot 1980).





b) Gas Section

Remove the two 4BA screws holding the pilot adaptor to the gas section and remove the pilot assembly complete. Care must be taken to avoid damage to the gasket.
Unscrew the burner nut and remove the burner with washer.
Remove the three 2BA screws holding the gas volume governor to the gas section.
Fit the new burner adaptor complete with fixed orifice restrictor in place of the gas volume governor together with the new gasket.
Fit the new burner assembly. (No washer is required at this joint.)
Fit the replacement pilot assembly to the gas section, making certain that the gasket is correctly positioned. Secure with the two 4BA screws.

c) Heating Body

Remove the lamel shell cap from the heating body and replace with the new one provided.
The lamel shell cap is situated in the centre of the heat exchanger. It is important that the part is positioned correctly.

d) Re-assembly and Testing

Refit the modified heating body using the washers provided for the hot and cold connections.
Locate the screw(s) holding the body strap to the burner tray. Fit the knurled screw at the back of the heating body, do not tighten at this stage.
Replace the drain plug together with washer.
Open fully the tap on the heater then turn on the water supply. When water is flowing freely from the spout the water tap can be turned off.
Refit the gas control knob and turn on the gas service cock or gas stopcock on the supply.
Apply a light to the pilot and turn the gas control knob anti-clockwise to the 'Pilot' position. Push in the gas control knob and turn to the fully 'ON' position.

e) Regulation

The nominal heat input is 35,000 Btu/hr and no gas adjustment is required.
For checking purposes, with an inlet pressure of 8.0 inches W.G. and a Wobbe Index No. of 1380 the burner pressure should be 2.8 inches W.G. ± 0.3 inches W.G.

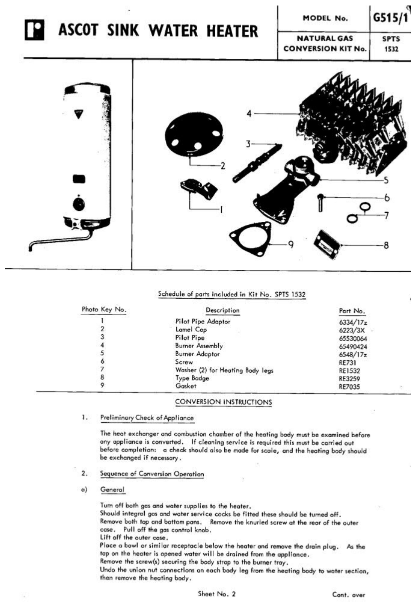
f) Final Assembly

After conversion it may be necessary to adjust both the water throttle and slow ignition device. Exchange the type and works number plate with the one provided.
Pull off the gas control knob then refit the outer case with top and bottom pans and refit the gas control knob. Tighten the knurled screw at the rear of the outer case.

Issue A. Aug. 1966

Ascot Gas Water Heaters Limited,
Radiation House,
North Circular Road,
London, N.W.10.

Sheet No. 2



ASCOT SINK WATER HEATER — MODEL No. G515/1 — NATURAL GAS CONVERSION KIT No. SPTS 1532

Schedule of parts included in Kit No. SPTS 1532

Photo Key No.	Description	Part No.
1	Pilot Pipe Adaptor	6334/17z
2	Lamel Cap	6223/3X
3	Pilot Pipe	65530064
4	Burner Assembly	65490424
5	Burner Adaptor	6548/17z
6	Screw	RE731
7	Washer (2) for Heating Body legs	RE1532
8	Type Badge	RE3259
9	Gasket	RE7035

CONVERSION INSTRUCTIONS

1. Preliminary Check of Appliance

The heat exchanger and combustion chamber of the heating body must be examined before any appliance is converted. If cleaning service is required this must be carried out before completion: a check should also be made for scale, and the heating body should be exchanged if necessary.

2. Sequence of Conversion Operation

a) General

Turn off both gas and water supplies to the heater.
Should integral gas and water service cocks be fitted these should be turned off.
Remove both top and bottom pans. Remove the knurled screw at the rear of the outer case. Pull off the gas control knob.
Lift off the outer case.
Place a bowl or similar receptacle below the heater and remove the drain plug. As the tap on the heater is opened water will be drained from the appliance.
Remove the screw(s) securing the body strap to the burner tray.
Undo the union nut connections on each body leg from the heating body to water section, then remove the heating body.

Sheet No. 2 Cont. over

Figure 5.1 Extracts from the Conversion Manual Developed by the Radiation group of Companies which Became the Forerunner to the Watson House Conversion Manual, with example pages. Source - National Gas Archive.

Manufacturers cooperated with the gas industry through the SBGI but felt, in the early stages at least, subject to considerable pressure, especially with regards to timing, limited planning opportunity and demands to produce a vast array of different conversion kits. The earliest realistic date for manufacturers to deliver conversion kits was June 1968, however, the large trial undertaken at Burton on Trent preceded this. This led to problems and the EMGB cited delays in the manufacture of conversion kits as a reason for hold-ups in its Burton on Trent trial conversion (Byford 1977, Elliot 1980).

The biggest impact on most gas appliance manufacturers was the amount of work involved in developing conversion sets for the immediate adaptation of non-current appliances. Current appliances, especially those designed as bi-fuel, could be converted relatively easy with a few inexpensive parts (Byford 1977).

Current production and non-current appliances were to be converted using conversion sets provided by the appliance manufacturers. These conversion sets would not be made available for obsolete appliances (out of production for more than 15 years) unless by special arrangement with a manufacturer where large quantities of a particular model were known to exist (Byford *et al* 1977).

A technical advisory panel comprising Conversion Technical Officers from the various regions with representatives from appliance manufacturers worked on improving conversion sets and once delivered, these led to a drastic drop in the level of call-backs (Byford *et al* 1977).

Some of the early surveys provided to the manufacturers were not extensive and therefore the estimates were tentative and required considerable revision, with significant increases in some conversion sets. Over time, the surveys became more accurate in identifying the correct number of conversion kits required. The focus on conversion sets meant some manufacturers had to reduce or in some cases stop producing new appliances in favour of conversion kits (Elliot 1980).

For some manufacturers, the conversion programme posed both a challenge and lucrative business opportunity. One appliance manufacturer, the Radiation Group of companies, provided conversion sets for more than three million cookers, two million water heaters, 1.7 million fires and 52,000 central heating units. This was on top of new appliances sold due to the replacement of obsolete models (The Radiation Group of Companies 1966, Elliot 1980, Hanmer and Abram 2017).

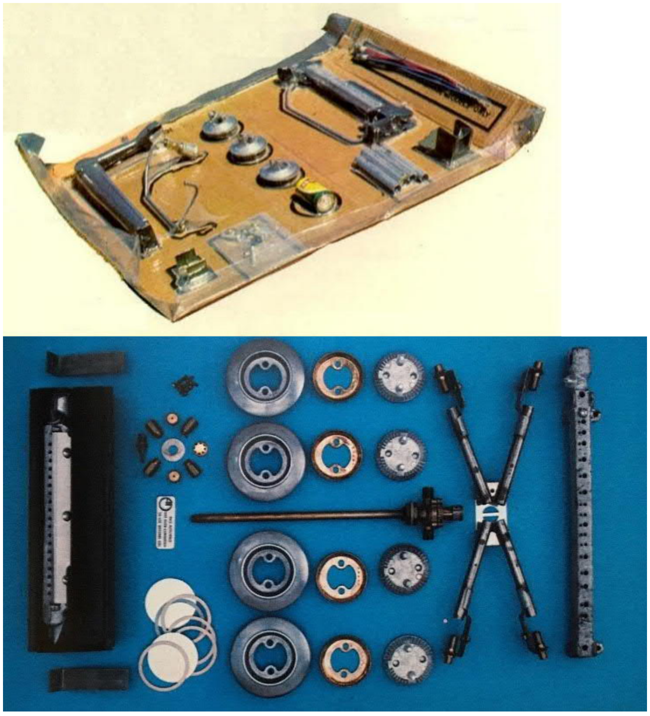


Figure 5.2. Examples of conversion sets, the example on the top using the skin packaging technique and the example on the bottom for a cooker. Source - National Gas Archive.

In line with gas industry policy, all conversion sets were to be approved by Watson House. This testing procedure was time consuming and further delayed the production of conversion sets, but it did provide multiple benefits through improved performance and more cost-effective production. Eventually, dissatisfaction with the conversion sets over the first two to three years prompted Watson house to undertake a new project to improve the conversion sets. Around 60% of the conversion sets were replaced by these new second generation conversion sets and, in some cases, they replaced the previous iteration (Elliot 1980).

Watson House and the manufacturers were hampered by the lack of access to natural gas for testing appliances in the early part of the conversion. This caused an added problem for the manufacturers, who had agreed through the SGBI that post 30th June 1967, all gas appliances should be multifuel, using either natural or town gas with minimal alteration (Byford *et al* 1977).

The manufacturers also had to provide instructions and packaging, which needed to be designed so items were not easily removed before conversion. Problems has occurred that when conversion kits were delivered to properties the owners would open the boxes and lose part of the kit, causing delays during the conversion process. To counter this, some manufacturers adopted skin-pack machines where the components were placed on a fibreboard backing and a plastic polythene sheet stretched around the pack, which made it possible to see the items, but they could not be easily removed. (Figure 5.2). Some items like radiants used on gas fires were prone to breakage and manufacturers had to develop new packaging for these fragile items. With a combination of more protective packaging and more careful handling by contractors, it greatly reduced the losses due to breakage and the delays these caused. (Byford et al 1977, Elliot 1980).

5.2 Preliminary work before conversion

There was a significant amount of preliminary work required to ensure the regional gas boards could prepare for conversion, some of which had been planned before the decision to convert. In each of the regional gas boards, the Conversion Department's Planning Section divided the regional gas network into smaller working areas or 'sectors', each having the appropriate number of customers and appliances. By balancing the conversion workload, it ensured the most efficient use of the available staff (Hindmarsh 1970). Initially, sectors were split depending on the number of consumers, but this switched to an approach based on the number and complexity of the appliances on the back of lessons learnt (Elliot 1980).

Using network analysis, distribution engineers undertook a detailed investigation of the gas network (Rhodes 1966, Elliot 1980). This ensured each sector could be supplied with town gas initially and natural gas after conversion without adversely impacting any other sectors during the programme. Engineers required the full details of the network in the sector, in particular changes in pipe diameter size and pipeline junctions. They then needed to identify appropriate locations for installation of the valves used to isolate the network. Mapping of the network was not always as accurate as would have been hoped and engineers had to be careful before making the final decision on where to locate them (Elliot 1980).

Although this proved a long and complex programme of works, this mapping ensured there were accurate records for the future and in some cases helped identify where reinforcements or cross-connections were required, thereby improving the network (Elliot 1980).

Installing conversion valves in a medium-sized town required several hundred valves, each needing excavation to carry out a flow stop operation followed by reinstatement of the area, causing disruption in public areas.

To enable a safe switch between town and natural gas, the engineers responsible for gas manufacture and distribution needed to collaborate. In the run up to conversion, the regional gas boards had greatly expanded their gas networks, mainly for the supply of reformed gas across the region. For those regional gas boards who bought gas such as that from coke ovens from a third party, existing contract commitments had to be considered and conversion was deferred in these areas until those contracts had expired (Elliot 1980).

Before any conversion could happen, engineering support was needed to provide bulk supplies of natural gas from the NGTS to the regional gas networks and for the construction of governor injection streams.

Sectors also needed to be ‘proved’ to ensure there were no unsuspected connections to other sectors and that demand would not be higher than anticipated. This was undertaken several weeks before conversion so time was available for remedial action. Proving was preferably carried out at the time of least public gas demand, so often after midnight. Planners needed to check both the weather forecast for cold weather and the TV schedules to ensure customers would not have a higher than usual demand for gas.

During this process, all but one valve on the sector was closed, with the last one being bypassed through a meter. Pressure was maintained at slightly less than normal for the sector. After accounting for known loads and for a small average consumption per customer (continuous industrial loads were metered), planners could work out if the sector was isolated. If they were unable to maintain reduced pressure, this indicated the sector was not isolated. Each valve on the sector was manually operated and fitted with pressure gauges to ascertain if the valve was working correctly or a leak was nearby (Figure 5.3). Within the SoGB, a team of typically 20 gas board employees and contractors would undertake the proving operation, starting at 11pm and finishing by 3am (Antony 1971, Elliot 1980).

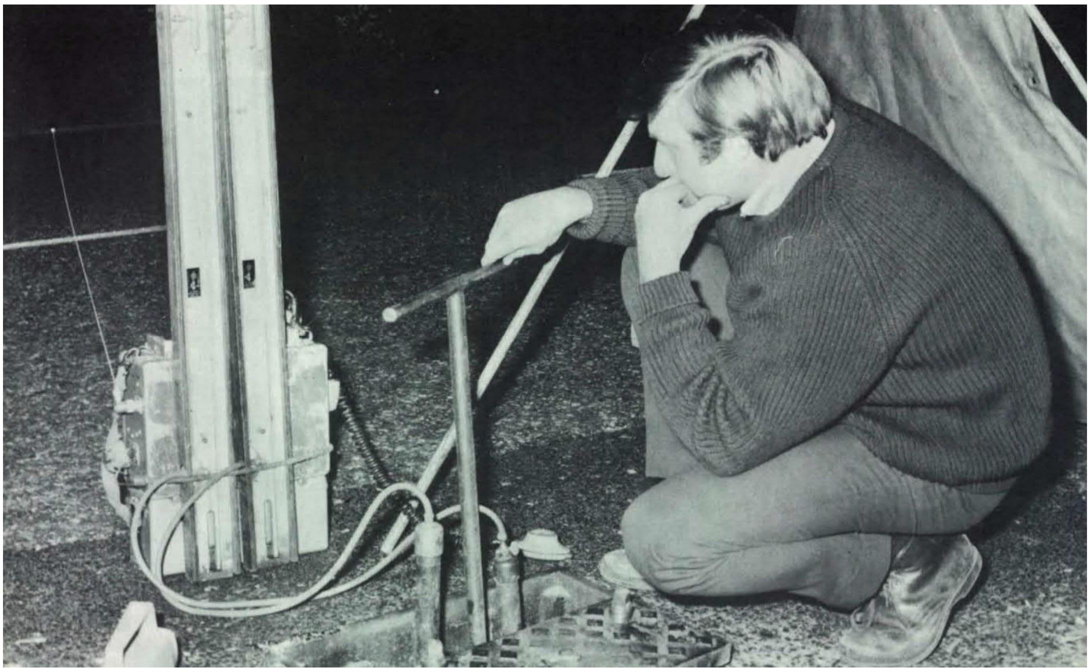


Figure 5.3. Getting ready to isolate a sector. a contractor turns off a gas valve and checks the pressure across the valve. Source - National Gas Archive.

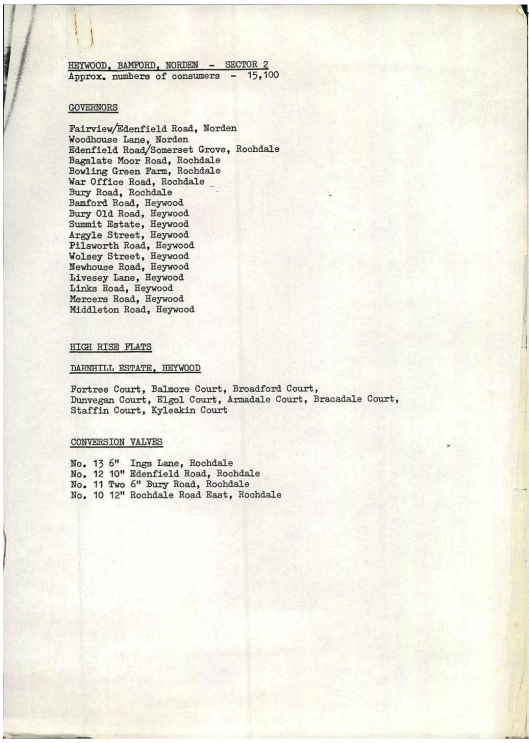
Communications also needed testing before conversion. Engineers had to be in regular contact with each other during many of the operations involved in conversion, especially during conversion day. They used field radios, but these were often limited in range. In rural sectors, specialised radio cars that masts to increase their range provided additional support to transmit and receive messages (Flame 1971).

One specific issue was the requirement for increasing the pressure on the districts, which was needed irrespective of conversion. Where the heating load had increased significantly, it was causing poor pressure in the gas mains. In 1964, the EGB had already started an Elevation of Pressure Programme, which involved raising the district pressure to 20” water gauge (0.049 bar) and the pressure at the meter inlet to 5.5” water gauge (0.013 bar). The main programme started in 1966 and involved 58,000 governors and filters fitted in sectors with poor pressure. When the decision to convert to natural gas was made in 1966, it was known this would help supplies because the new gas would double in calorific value, but it needed to be supplied at a higher pressure to appliances. So, before conversion, regional boards needed to undertake a mains pressurisation programme (Vincent 1967).

The gas network was split into sectors with equivalent numbers of consumers. An example taken from the NWGB is shown in Figure 5.4, with the specific high-level details of the sector including:

- Name and number of consumers
- Supplying holder station/gasworks
- Location of Governors
- Location of any high-rise flats
- Location of conversion valves

Accompanying OS maps (Figure5.4) were marked up with the location of conversion valves and other details.



HEYWOOD, BAMFORD, NORDEN - SECTOR 2
Approx. numbers of consumers - 15,100

GOVERNORS

Fairview/Edenfield Road, Norden
Woodhouse Lane, Norden
Edenfield Road/Somerset Grove, Rochdale
Bagslate Moor Road, Rochdale
Bowling Green Farm, Rochdale
War Office Road, Rochdale
Bury Road, Rochdale
Bamford Road, Heywood
Bury Old Road, Heywood
Summit Estate, Heywood
Argyle Street, Heywood
Pilsworth Road, Heywood
Wolsey Street, Heywood
Newhouse Road, Heywood
Livesey Lane, Heywood
Links Road, Heywood
Mercers Road, Heywood
Middleton Road, Heywood

HIGH RISE FLATS

DARNHILL ESTATE, HEYWOOD

Fortree Court, Balmore Court, Broadford Court,
Dunvegan Court, Elgol Court, Armadale Court, Bracadale Court,
Staffin Court, Kyleakin Court

CONVERSION VALVES

No. 13 6" Ings Lane, Rochdale
No. 12 10" Edenfield Road, Rochdale
No. 11 Two 6" Bury Road, Rochdale
No. 10 12" Rochdale Road East, Rochdale

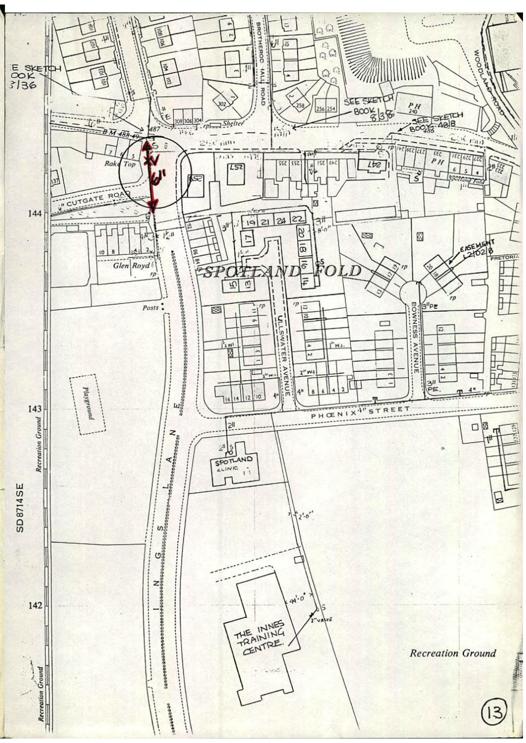


Figure 5.4, examples of the sector details for the NWGB in the Heywood, Bamford and Norden area, Sector 2. Source - National Gas Archive - document ref:16305.

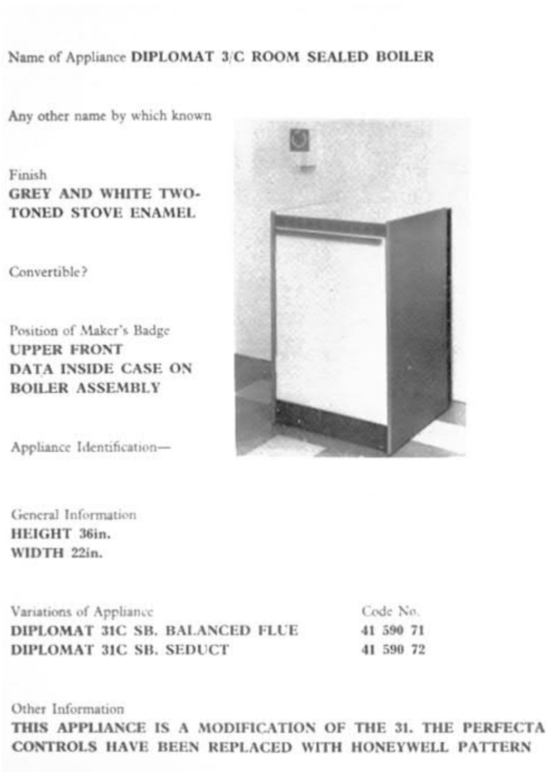
Once the sectors were identified, the boards obtained and listed the names and address of all the actual customers within them. The list would then be split into domestic and non-domestic customers and surveyors were assigned one or the other due to the different appliances likely to be encountered at each.

The Conversion Identification Manuals produced by Watson House for the Gas Council were used as reference books, provided to help surveyors identify the various appliances. Manuals were divided into three main categories:

- Domestic
- Commercial
- Catering

These three primary categories were divided further into subsections, for example, the domestic manuals included subsections on cooking and space-heating.

They contained photographs and various other bits of information to help the surveyor identify appliances. Manuals also provided a seven-digit Gas Council code for each individual appliance. The first two digits represented the type of appliance, the next three digits the manufacturer and the final two variations of type of appliance in the manufacturers' ranges.



Name of Appliance **DIPLOMAT 3/C ROOM SEALED BOILER**

Any other name by which known

Finish
GREY AND WHITE TWO-TONED STOVE ENAMEL

Convertible?

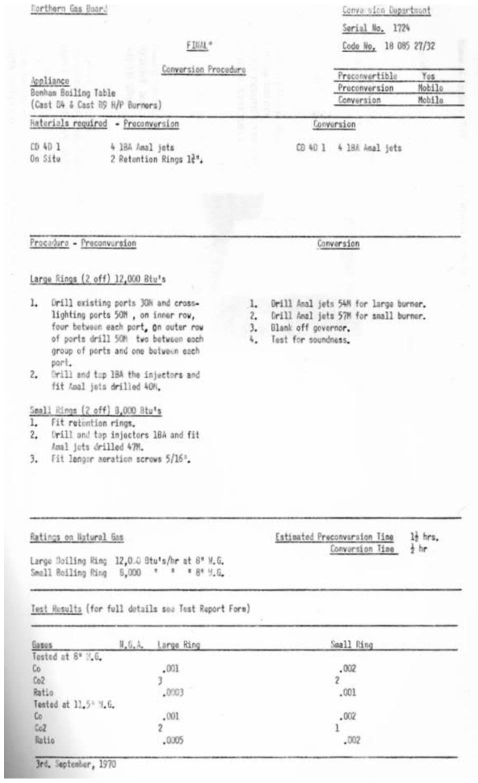
Position of Maker's Badge
UPPER FRONT
DATA INSIDE CASE ON BOILER ASSEMBLY

Appliance Identification—

General Information
HEIGHT 36in.
WIDTH 22in.

Variations of Appliance	Code No.
DIPLOMAT 31C SB. BALANCED FLUE	**41 590 71**
DIPLOMAT 31C SB. SEDUCT	**41 590 72**

Other Information
THIS APPLIANCE IS A MODIFICATION OF THE 31. THE PERFECTA CONTROLS HAVE BEEN REPLACED WITH HONEYWELL PATTERN



Northern Gas Board

Conversion Department
Serial No. 1724
Code No. 18 085 27/32

FINAL"

Conversion Procedure

Appliance
Benham Boiling Table
(Cast D4 & Cast B9 H/P Burners)

Preconvertible	Yes
Preconversion	Mobile
Conversion	Mobile

Materials required - Preconversion

CD 40 1 — 4 18A Amal jets
On Site — 2 Retention Rings 1¾".

Conversion

CD 40 1 — 4 18A Amal jets

Procedure - Preconversion

Large Rings (2 off) 12,000 Btu's

1. Drill existing ports 30M and cross-lighting ports 50M , on inner row, four between each port, On outer row of ports drill 50M two between each group of ports and one between each port.
2. Drill and tap 18A the injectors and fit Amal jets drilled 40M.

Small Rings (2 off) 8,000 Btu's
1. Fit retention rings.
2. Drill and tap injectors 18A and fit Amal jets drilled 47M.
3. Fit longer aeration screws 5/16".

Conversion

1. Drill Amal jets 54M for large burner.
2. Drill Amal jets 57M for small burner.
3. Blank off governor.
4. Test for soundness.

Ratings on Natural Gas

Large Boiling Ring 12,000 Btu's/hr at 8" W.G.
Small Boiling Ring 8,000 " " " 8" W.G.

Estimated Preconversion Time 1½ hrs.
Conversion Time ½ hr

Test Results (for full details see Test Report Form)

Gases	N.G.A.	Large Ring	Small Ring
Tested at 8" W.G.			
Co		.001	.002
Co2		3	2
Ratio		.0003	.001
Tested at 11.5" W.G.			
Co		.001	.002
Co2		2	1
Ratio		.0005	.002

3rd. September, 1970

Figure 5.5 An example of a description of an appliance (left) and an example of a conversion procedure (right) from the Gas Council Conversion manual. Source - National Gas Archive.

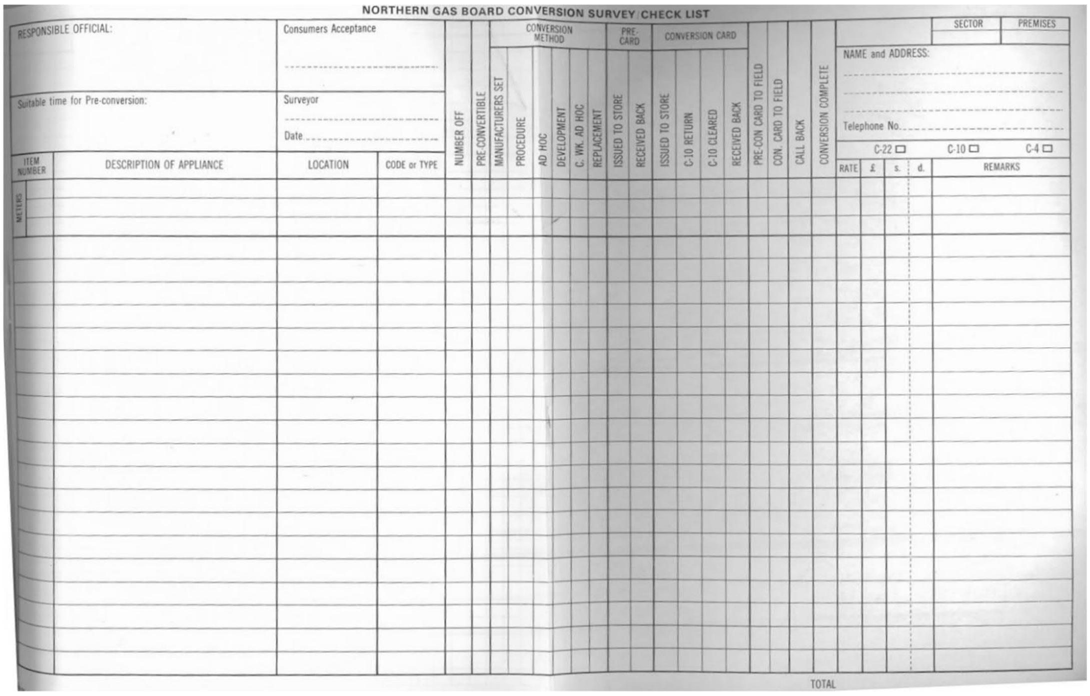
If surveyors could not identify an appliance, they used a Polaroid-type camera to take photographs and then make notes about it.

Their first role was to classify the premises. Customers were classified based on the appliances in the property and not the property itself. If a commercial premises was visited by a commercial surveyor but only had domestic appliances, it would be transferred to a domestic surveyor and included in that programme. Likewise, if it had only industrial appliances, it would be switched to an industrial surveyor (Hindmarsh 1970). With all premises classified, the survey would happen later.

Surveyor's took details of the meter, including the year of manufacture, the manufacturer, serial number, the size of service, size of the meter (ft^3/hr), their location and any other relevant information, i.e. if it needed moving (Hindmarsh 1970).

To stop dust being transferred from the mains and services into the meter, a filter had to be fitted. The regional survey and the fitting of filter and governor units, along with a programme for meter inspection and replacement (where necessary), were carried out independently of the conversion programme (Hindmarsh 1970, Richardson 1977).

The surveyor would then work through the appliances in the premises taking down the information and adding it to the survey record (Figure 5.6).



NORTHERN GAS BOARD CONVERSION SURVEY/CHECK LIST

RESPONSIBLE OFFICIAL:

Consumers Acceptance

Suitable time for Pre-conversion:

Surveyor

Date

SECTOR | PREMISES

NAME and ADDRESS:

Telephone No.

C-22 ☐ C-10 ☐ C-4 ☐

ITEM NUMBER	DESCRIPTION OF APPLIANCE	LOCATION	CODE or TYPE	NUMBER OFF	PRE-CONVERTIBLE	CONVERSION METHOD: MANUFACTURERS SET	PROCEDURE	AD HOC	DEVELOPMENT	C. WK. AD HOC	REPLACEMENT	PRE-CARD: ISSUED TO STORE	RECEIVED BACK	CONVERSION CARD: ISSUED TO STORE	C-10 RETURN	C-10 CLEARED	RECEIVED BACK	PRE-CON CARD TO FIELD	CON. CARD TO FIELD	CALL BACK	CONVERSION COMPLETE	RATE	£	s.	d.	REMARKS
METERS																										

TOTAL

Figure 5.6. an example of a conversion survey form. Source - National Gas Archive.

Surveyors would spend one day a week in the office processing the surveys and handing over their classified printouts to the administrative team to progress the conversion classifications. Each appliance Gas Council code number would provide the method of how the appliance was to be converted or dealt with. These typically were:

- ‘Set’: this would mean a conversion set was available from the original manufacturer or another manufacturer has developed a set to convert this appliance.

- ‘Ad hoc': when a conversion set could not be obtained from a manufacturer, the Conversion Department's technical staff would have to develop a conversion protocol themselves. With these conversions, as much work as possible was carried out in advance.
- ‘Procedure’: when an Ad Hoc conversion had been done, the Technical Assistant who performed the operation would draw up a specification of what was required to convert the appliance and step-by-step instructions on how to convert it. This was filed in the Conversion Department and given an individual procedure number should the appliance be encountered again.
- ‘Replacement’: a replacement appliance would be offered to the customer.
- 'Sell out': if it was considered dangerous or exceptionally difficult to convert an appliance, an allowance was given to the consumer to change the appliance.

The conversion method was then transferred to the survey sheet and kept on file, so the methods and the relevant materials were delivered to the premises ready for conversion.

Hindmarsh (1970) highlighted the importance of the survey, saying: “Accurate surveys means successful conversion, successful conversion means contented consumers, contented consumers are the ambition of the Conversion Department.”. Without an accurate survey, the steps outlined below would have been vastly more difficult.

5.3 Training

Training was highlighted as an issue at the start of conversion. This was due to the sheer number of staff required to undertake the feat, many of whom were unlikely to have had previous experience in gas engineering (Elliot 1980). It was estimated that, nationally, there were fewer than 14,000 manually skilled gas industry employees who could be trained for conversion, but not many of them could be released from their day-to-day jobs (Smith 1977)

Since a reasonable conversion timeline was impossible with the existing labour force of gas fitters, contractors and the two gas boards who undertook the work internally set up training schools. They then launched intensive programmes, firstly to establish the training schools, ensure sufficient effective training personnel, develop methods and provide equipment and then to launch the training. The gas boards and contractors had some 10,000 conversion operatives in the field, but the schools needed to train at least twice this figure to maintain an adequate workforce. This was in part due to converters leaving as the operation moved geographically, retirements and other industries recruiting newly trained contractors (Richardson 1977).

Both the regional gas boards and the contractors had to be selective in the choice of staff, not only in their technical skills but also in their character and personality given they would be working in customers' homes and in constant contact with the public. Applicants were assessed for their aptitude, appearance, and general demeanour. Those who were accepted then went through the training, where they were expected to progress in the skills and knowledge required. Those failing the test at the end of the training were not offered employment (Elliot 1980).

Working as a fitter was a challenge. It was nomadic life, involving long hours and moving from sector to sector regularly. For some, it was their first time working away from home. The work was varied, with many ad hoc conversion challenges faced by the converters daily. At the time, the labour market was in a poor state, so applications were numerous and of a largely suitable quality for the high selection standards required (Richardson 1977).

Figure 5.7. Training fitters and foremen in the classroom and hands-on training in the Reading workshops converting a cooker. Source - National Gas Archive.

The generic converter training courses carried out by the gas boards or contractors would take four to six weeks. Initially, this was thought to be sufficient, but it was realised a further period of around weeks of training under supervision was required. To become a more skilled level of operative such as advanced converter or senior conversion fitter, additional training and on-the-job learning was essential (Richardson 1977, Elliot 1980).

In all, 13 conversion training centres opened. HGS, a collaboration between Humphreys and Glasgow and Sofregaz of France, opened a training centre at Redhill in Surrey in January 1970. It was located within SEGAS territory where they were working as conversion contractors and opened with SEGAS Chairman Mr Nigel Bruce converting a Radiation cooker (Anon 1970b).

As part of this project, a survey of former gas engineers who worked on conversion was carried out. Their views provided insight into the reality of the training programme. The survey found that staff had been given very good training, although some described it as sufficient. A few responded they had not had specific training but had already been through gas board training programmes and received on- the-job training and mentoring. Training was mostly face to face in a workshop or classroom with skilled instructors.

One engineer stated their role as a surveyor was made easier by the excellent appliance identification manuals (complete with photographs) produced by Watson House and the appliance manufacturers. The biggest problems occurred where there were gas escapes or faulty installations. One respondent mentioned training was done in house by NEGB, one of the regional gas boards that undertook conversion by itself. One industrial gas engineer highlighted the training was mostly theoretical as there had been little practical experience gained at that point.

There were some negative comments, including: "*I felt we were not fully briefed on what to expect on 'C Day'. The first appliance I dealt with was a nerve-racking experience," while another engineer responded some had carried out conversion in a "haphazard way".*

Specialist training for regional gas board staff and contractors was organised by the Gas Council and the Gas and Construction Industry Training Boards, working with the General and Municipal Workers Union to ensure training syllabuses were available and to the necessary standard. Training consisted of a combination of lectures and demonstrations with practical exercises (Gas Council 1969, Richardson 1977, Elliot 1980).

Work study exercises consisted of (Richardson 1977):

1. Make safe
2. Turn down
3. Soundness testing
4. Premise allowances for all categories of appliances
5. Allowances to cover collection of wages
6. Call back penalties
7. Levels of existing work performance
8. Call back and sweep operations
9. Pre-conversion for non-domestic work

Eventually, four different group schemes were tailored to suit the particular requirements of the conversion operation and they were introduced in the following sequence (Richardson 1977):

1. Domestic conversion
2. Domestic sweep
3. Domestic call-back
4. Non-domestic conversion and call-back

There were different grades of conversion operatives: Converter, Advanced Converter, Conversion Fitter Grade 2, Conversion Fitter Grade 1 and Senior Conversion Fitter (Richardson 1977).

Training was required across the whole cross section of gas board employees. The Customer Service department were regarded as having a long-term involvement with natural gas after conversion and its personnel required intensive training before conversion. The-other main specialist training was provided for surveyors, who were expected to meet the same high standards of aptitude, appearance and character due to their involvement with the general public. The focus here was on the correct identification of appliances, accurate survey completion and record cards. Training was provided at a more peripheral level for those across the industry, from senior management to the showrooms (Smith 1977, Elliot 1980).

The conversion of industrial equipment required specialised knowledge and the Gas Council ran a series of courses each lasting a week at the Midlands Research Station. As part of the residential courses (see below) held at Pembroke College, Dr Peter.B. Simpson, the area industrial gas manager of the East Midlands Gas Board, presented a lecture on t of 'Planning a Major Industrial Conversion' (Gas Council 1969).

The Institution of Gas Engineers developed a series of short residential training courses at Pembroke College in Oxford, starting in 1966. These were aimed at staff in the regional gas boards and the Gas Council. The lecturers were given by eminent people in the Gas Council, Watson House or the regional gas boards, such as Brian Healy and Clifford Purkis. Subject matter included the experience gained from the preliminary conversion work at Watson House, the Canvey Island pilot trials and other early trial conversions, such as Burton on Trent. These courses covered a range of subjects, including:

- Conversion Problems on the District (Rhodes 1966)
- Domestic and Commercial Conversion (Fox-Andrews 1968)
- Technical Background to Conversion (Purkis 1968)
- Training for Conversion – The Approach of the Board (Skilton 1968)

- National Coordination of Conversion (Healy 1968)
- Accounting and Financial Implication of Conversion (Davis 1968)
- Transmission and Distribution (Firth 1968)
- Planning a Major Industrial Conversion' (Gas Council 1969)

Training schools were maintained right until the end of the conversion because staff would retire or leave. But contract conditions, wages and the team spirit built up between the conversion staff minimised these losses to the industry. One of the most important decisions taken was the creation of the Gas Conversion Association. Formed by the major contractors, it normalised conditions of employment for converters, agreeing these with employees and negotiating with the trade unions. The main agreement was struck in 1969 and reviewed each year (Richardson 1977, Elliot 1980).

All regions introduced incentive schemes to maintain motivation and performance. This was an important part of the main agreement secured for converters through the Gas Conversion Association. The benefits of improved performance were shared between the employer and employee. If the standard time allocation of conversion hours per appliance was improved upon by the converter, an incentive payment was made from the savings generated. This was usually made two weeks in arrears, which was soon enough to demonstrate the reward obtained (Richardson 1977, Elliot 1980).

The workforce was encouraged to keep working on the conversion programme until completion using a terminal payment. This avoided the loss of a highly skilled workforce and the cost of retraining new staff for what may only have been a short period. The Gas Conversion Association proposed the terminal payment to the Gas Council if the employee remained in post until advised their services were longer needed. This payment, combined with the State Redundancy Scheme, amounted to a significant sum and minimised staff turnover until the programme was completed (Richardson 1977, 1980).

5.4 Logistics, purchasing, stores and administration.

Some of the less visible but equally important aspects of conversion were the logistics, purchasing, stores and administration functions. These were vitally important to ensure everything, and everyone was where it should be at the right time.

The conversion delivery team is shown in Figure 5.8. This shows the central role of the Conversion Manager and their support team, which included liaison with headquarters and other departments. It shows the team of administrators and clerks who supported the conversion unit by processing the surveys and conversion information. The important role of the fixed and mobile workshops in providing facilities for undertaking conversions that could not be undertaken on site is also shown.

The survey team under the Survey Officer was clearly separate to the Operations Officer controlling the conversion team. The support role provided by the technical officer and laboratory staff to assist conversion is clear. Mobile stores would liaise with central stores in the Purchasing and Supplies department. Likewise, the transport department (not shown) provided logistical support to the conversion unit for transport, mobile offices and workshops. The Distribution Department is also not shown, but regularly liaised with the conversion team during sectorisation, proving and conversion day.

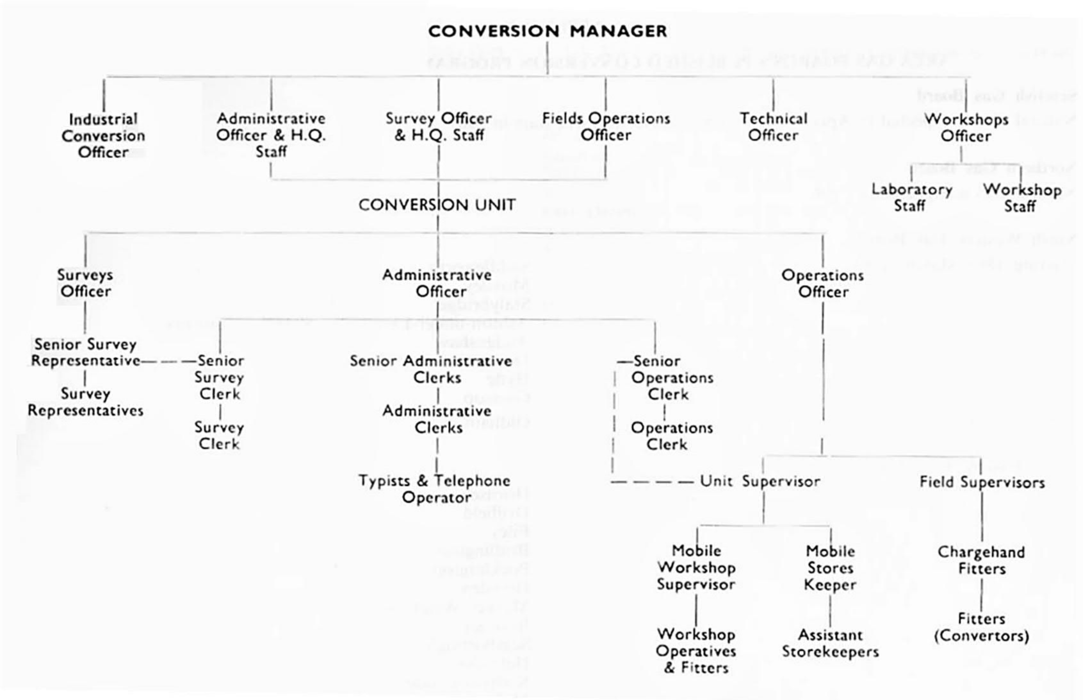


Figure 5.8. The structure of a typical conversion department (Ellis and Aspinall 1968). Source - National Gas Archive.

The role of the Purchasing and Supplies function was critical to the success of the operation. In all regions except one, this function, including stores organisation and administration, remained with regional directors of Purchasing and Supplies. The day-to-day arrangements to ensure the availability of conversion sets, spare parts and other materials was crucial to conversion performance and customer satisfaction. This interface was recognised from the start as critical and the Conversion Executive initially embraced the purchasing function in determining national materials requirements and ensuring adequate production facilities. Purchasing was considered as much a part of conversion as Planning and Technical aspects were (Smith 1977).

The Purchasing and Supplies departments were responsible for agreements with conversion set producers and appliance manufacturers for which conversion sets were made. They also developed a tendering procedure that gave appliance manufacturers preference of supply for conversion sets, subject to acceptable standards of quality of product, rate of supply and price (Smith 1977).

Figure 5.9. Packaging conversion kits at the Bicester Stores of the SGB in 1969. Source - National Gas Archive.

While the headquarters (Gas Council) recommended suppliers and prices of all approved conversion sets original and modified, regions were responsible for ordering conversion sets and delivery schedules but could take advantage of nationally agreed prices. It was not only conversion sets that were in demand; the demand for spare parts in conversion areas was twice the normal amount and preliminary work brought an increased requirement for meters (Smith 1977). Conversion Control Centres coordinated the supplies of conversion sets to the different regions and later in the programme would reassign terminal stocks from completed regions (Smith 1977).

Conversion accommodation was often temporary and field conversion units comprised either portable buildings frequently re-sited or existing accommodation on regionally owned sites.

The use of mobile, temporary, or permanent structures during conversion was dependent on what was available and where. In some cases, where the gas board had vacant property such as a store or workshop, this could be repurposed for use during conversion. SoGB took the innovative step of using inflatable stores constructed on their sites as temporary conversion stores. This was in addition to expanding their regional stores, such as that shown at Bicester in Figure5.9.

5.5 Operational journey

Before natural gas could be introduced to the sector, the gas supply to each premises had to be turned off, a step referred to as 'Make Safe'. This was the first major operation on conversion day and no further work could be carried out until it was confirmed every premises had been turned off. Distribution engineers were on hand in case conversion engineers could not access premises. If they were also unable to gain access, they would locate the service outside the property and cut it off. Once confirmed that every premises had been disconnected from the gas network, the field engineer would inform the engineer in charge.

On conversion day the Distribution Engineers would be responsible for switching the sector from town gas to natural gas, a process known as 'Turn-in'. This had to be completed as early as possible to enable the conversion fitters to start the conversion of premises. It could only begin after the field engineers had informed the engineer in charge and they had given the go ahead. As with 'Proving', engineers were assigned to each valve (connected to adjacent sectors) that had to be closed in a particular order, with a single valve left open through which the natural gas would enter. Once complete, the 'Burn off' or 'Flare off' would take place at different points across the sector. Gas pressure had to be maintained to ensure no air got into the main, creating the risk of an explosive mixture.

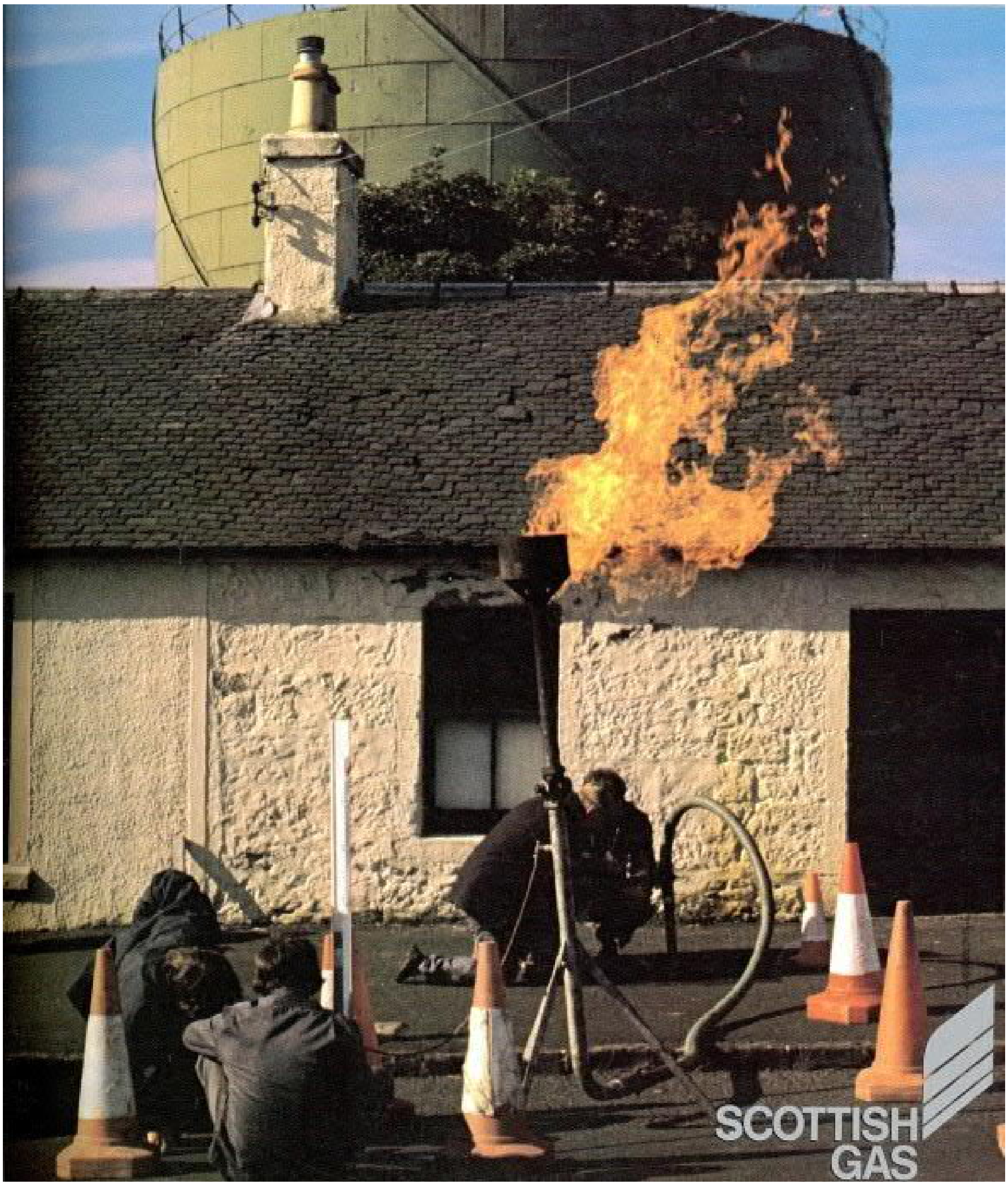


Figure 5.10. Flaring off gas at Muirkirk, Scotland, during “Turn In”. Source - National Gas Archive.

Gas would then be vented from ‘Flare off’ points situated in the road or footway around the sector, which were controlled by an engineer who watched the gas burning until the neat blue flame of natural gas showed on the flare equipment. An additional check would be made with a methane meter. Once the engineers in charge had confirmation that town gas had been purged from all flare points, the flares were cut off.

Monitoring would also be undertaken on the valves isolating any sectors with town gas to ensure no natural gas was escaping into the town gas sectors. The Field Conversion Manager then informed the conversion teams that reconnection with the premises could be made and work on converting the appliances could proceed (Elliot 1980). While conversion day saw the introduction of natural gas into the sector, it did not mean all customers would be converted that day. Typically, vulnerable customers and those with young families would be dealt with first and the engineers tried to ensure each property had at least a hot plate to cook with. However, full conversion could take three to five days and, in some cases, appliances had to be removed and converted in workshops.

The conversion process was not incident free. In the NTGB area, miscommunication allowed natural gas to enter a town gas sector through a valve being left open between two areas. This resulted in the governor being shut down and a ‘gas off sector’ emergency in the affected area. As a result, it was decided just one person should be in charge in situations where two areas are involved. Also, in the NTGB area, the presence of an unknown commercial heating boiler caused issues. It had been installed post survey and before conversion, so converters were unaware of it. It was using a substantial amount of gas, which was detected when the sector was being ‘proved’. This caused a great deal of disruption in the area and was finally resolved when the plant stopped at 6pm and its location was identified (Collins and Greene 1977).

The time taken for ’Make Safe’ and ‘Turn In’ could vary on different sectors and was affected by the geographical size of the area and number of valves and purge points. It could also be delayed by having to cut off any supplies to premises where customers were not present or where access was not available. Typically, it would be completed within two and a half to three hours (Elliot 1980).

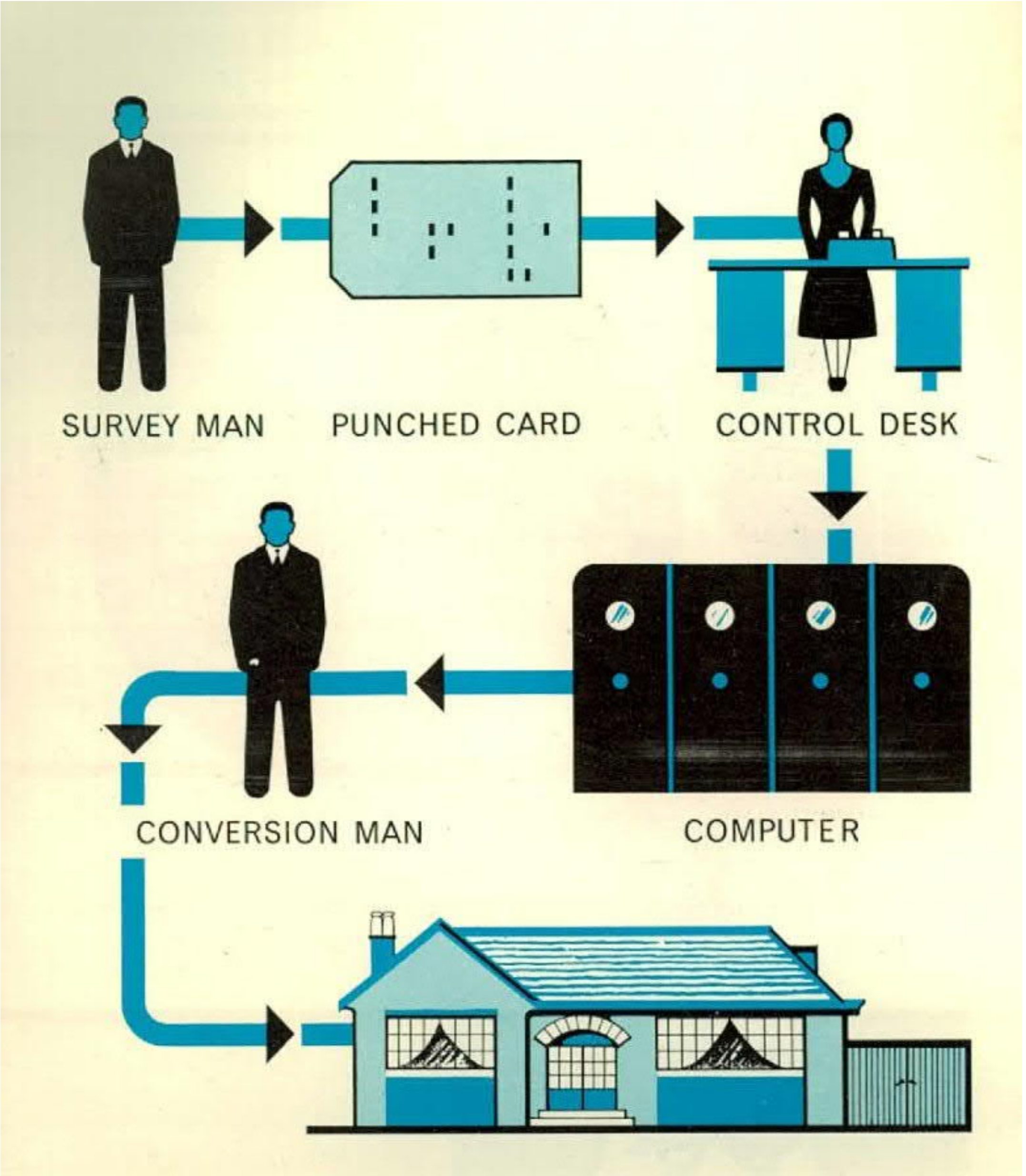


Figure 5.11 A NEGAS Cartoon representing the conversion process in simple terms to the customer. Source - National Gas Archive.

Matters were complicated where only a single main supplied multiple sectors in a town. In such cases, an alternative gas supply was required, either through a temporary above ground main or a supply of LNG or substitute natural gas (propane/air). Each had safety risks, especially LNG, where stringent safety precautions were needed, which included having a suitable site to house the vaporising, odourising, pressure control and metering plant (Elliot 1980). An example of the use of substitute natural gas is shown in section 6.4.

The two-stage conversion principles copied from the industrial and commercial sector were adopted for some domestic regions. This involved the first phase being completed a few weeks before the arrival of natural gas. This approach, when used by the WGB, did not have a positive impact on conversion cycle workload, greatly increased inconvenience for the customer and led to a near doubling of costs. As a result, one-stage conversion was adopted as the preferred option (Smith 1977, Elliot 1980).

The assumption the general condition of gas appliances would be suitable for conversion to natural gas proved wrong. Due to the poor condition of some existing appliances, there were extensive additional costs due to servicing, repairs and replacements. As a result of these additional works, the conversion programme also took longer to complete.

However, one of the unexpected consequences of the conversion was that it resulted in many dangerous and/or potentially dangerous appliances and fittings being rectified or removed. This helped ensure higher and safer standards of gas installation workmanship (Smith 1977).

Each regional gas board offered its own unique challenge, from the relatively small but densely populated NTGB to the very large ScGB, which was more sparsely populated and had many isolated gas networks. In the case of the latter, Maurice Redman, the Chairman of Scottish Gas remarked: “Conversion has been a tough job in every region of the British Gas Corporation, but Scotland presented its own special problems, especially with its very large geographical area and the climate.” (Redman 1977)

By contrast, city centre conversions were less challenging than anticipated, mainly due to effective public relations and resource planning. Also, the conversion of larger cities also generally came later on in the conversion programme when many of the earlier technical difficulties had been resolved (Byford *et al* 1977). This was not the experience everywhere. In Glasgow, it was necessary to convert continuously for nearly two years and this posed particular public relations problems, especially due to the high concentration of industrial and commercial customers encountered there (Redman 1977).

Figure 5.12. a label to be stuck to cooker prior to conversion, showing the 'Turn Down' approach. Source - National Gas Archive.

The 'Turn Down' technique was used by many regional gas boards. This enabled natural gas to be used on the cooker hotplate before the appliance was converted if the gas control was only half on. This was discussed with customers and a sticker attached to the cooker as shown in Figure 5.12. Gas ovens and grills would in some cases not be available for a couple of days, so all meals would be prepared on the gas hob. Dishes were designed by the region's Home Service Advisers for cooking on gas rings and included framed eggs, quick kippers, Dutch eggs, Granny Parkin's quick beef stew, frying pan pizza, fruit fitters and crunchy apple custard (McCawley 1977).

Educating the customer about the above proved problematic. As one of the respondents to the questionnaire instigated as part of this project highlighted, the biggest challenge was 'educating customers, especially on conversion day when using their cooker on turn down before the cooker was converted to natural gas'.

In the course of the conversion programme, some 7,976 different types of gas appliances (cookers, fires, refrigerators and central heating boilers) were identified, and conversion procedures designed for them (Anon 1977). When conversion started in 1968/69, some 400,000 domestic conversions were completed in one year. By 1970, this had reached two million a year (Anon 1977).

5.6 Commercial conversion

During the programme, some 386,000 commercial appliances were converted. This was challenging due to the variety of catering plant identified: 7,097 with 2,172 approved conversion sets and 890 unapproved sets (Wilson 1976). According to Elliot (1980), the item with the most varieties were Hotcupboards and Bain Maries, of which there were 1,588 different types. The commercial survey was normally carried out 52 weeks ahead of conversion day and the request cards for the conversion kits sent to stores 26 weeks before conversion day.

Commercial gas fires and central heating systems tended to be different to those found in domestic properties and the survey encountered small numbers of unusual items such as incinerators and dishwashers. With a greater number of non-standard items, commercial conversion was expected to be a slower process. Although conversion sets did become available, some of these were unapproved and used at the gas boards' discretion (Elliot 1980).

These conversions required the greater involvement of Watson House, which approved a set of procedures followed by many of the regional gas boards that carried them out. This resulted in a lot of information being exchanged between Watson House and the regional gas boards to support these ad hoc conversions.

Due to the variation of workload between sectors, much of the commercial pre-conversion work was attempted out of working hours to avoid inconvenience, for example, at hotels where work could be done out of season. This would minimise inconvenience to customers on the actual day of conversion. In some cases, bottled gas was also provided to minimise inconvenience for sensitive operations.

The term 'commercial customer' covered everything from a small café to a large public building, hospital, or army barracks. Regional gas boards would try to convert holiday resorts out of season; however, this was not always possible if the programme slipped, as it did in Cornwall, or due to constraints on the gas network, as there were in Blackpool (Bennett *et al* 1974, Elliot 1980).

The most problematic of all commercial appliances were fish fryers used in fish and chip shops. These were usually operated at maximum capacity or overloaded by their owners and, post conversion, the fitter would typically adjust them to their correct performance, often below that achieved previously by the shop owner.

Finnigan (1969), who took a particular interest in the matter, said: "*They caused more problems than any other appliance. They are usually grossly over-rated; the general* *condition of the appliance is often poor and the installation of a low standard. The pace of business, the operator's particular method of frying, the size and design of the combustion chamber and flue outlet, trunking and termination, plus the gas rate are the factors that have been found to vary widely, thus resulting in individual methods of conversion for each."*

Fish fryers were therefore given a lot of attention during the survey and after conversion, with repeated technical tests to ensure they were working correctly (Elliot 1980).

For hospitals, special provisions were made as these sites were busy every day of the year. Extensive planning was undertaken in cooperation with hospital staff in all the departments affected. This would include the prior conversion of a standby unit to natural gas and the provision of bottled gas for heating, cooking, and the laboratories. Often, the specialist equipment had to be replaced completely.

5.7 Industrial conversion

Industrial conversion was isolated in many ways from the domestic and commercial conversion programme, which by comparison dealt with much smaller appliances. In total, there were only believed to have been 80,000 industrial customers for all the regional gas boards at the start of the programme. These had regular liaison with specialist industrial gas engineers at the regional gas board, who knew the customers' gas plant well and gave the regional gas board a good idea of what may be involved. Conversion of larger industrial facilities were often undertaken as a joint effort, irrespective of whether they were an existing or potential new customer (Gas Council 1969, Elliot 1980). The first industrial conversion had been undertaken at Murex Ltd in Essex in 1965 around the same time as the Canvey Island Pilot Trial (Gas Council 1969).

Table 5.1 shows he greatest number of industrial customers was in the NTGB, whereas the highest gas industrial heating demand came from the WMGB. The NGB had the smallest number of industrial customers, but the lowest industrial heating demand was in the SoGB (Gas Council 1969). The Gas Council estimated that if, on average, each industrial consumer had eight appliances, this could equate to 650,000 conversions, which over the estimated 10-year programme would be 65,000 conversions a year or 180 per day (Gas Council 1969). This figure, however, did not include winning new industrial customers that would switch from other fuels. Given the abundance of North Sea natural gas, new customers, especially those close to the NGTS, could be easily switched to natural gas.

Table 5.1 Industrial gas load 1966/67 (Gas Council 1969)

Regional Gas Board	No. of Industrial Customers	Gas Sold (Thousand Therms*)
Scottish	5,050	61,709
Northern	1,370	57,558
North Western	10,767	131,332
North Eastern	6,271	51,549
East Midlands	6,885	165,148
West Midlands	10,753	198,775
Wales	2,001	46,885
Eastern	5,867	41,496
North Thames	19,218	73,153
South Eastern	6,877	37,227
Southern	2,378	21,169
South Western	2,793	22,404
Total	**80,230**	**908,375**
*1 therm = 105 Megajoules		

At the time, the gas industry did not have a dominant position in the industrial energy market. This was very much a market they hoped to target through the benefits natural gas would bring. Industrial conversion to natural gas was driven by the advantages of natural gas over other fuels, which were generally regarded as (Poole 1972):

- Lower cost
- Greater combustion efficiency
- Ease of control and hence easy adaptation to automation
- Reduction in labour costs for fuel handling, ordering etc.
- Reduced emissions as virtually sulphur free
- Reduction in maintenance costs of burners and control equipment.

Other benefits quoted were price stability and, where replacing oil or coal as a fuel, reduced vehicle movements in fuel deliveries (Walker 1972).

The Gas Council had targeted a six-fold increase in gas sales to industrial customers in the 10 years from 1965. It had developed and promoted Total Energy schemes, where natural gas would be used to supply all energy needs of a particular project. It also developed Interruptible Contracts, where lower prices would be offered to industrial and commercial customers that were able to switch to another fuel for defined intervals when given an agreed notice period. These contracts boosted gas sales while also helping the gas industry manage times of peak demand (Gas Council 1970).

Although industrial gas use was not as extensive as it became many years later, it did take a significant supply in some regional gas boards. By converting these customers early, it reduced demand for town gas and provided a benefit by removing the need to build costly new gas reforming plant, which would not be required in the long term (Hoof 1968).

Industrial conversion usually also included other commercial plant that might be present on the site, such as those appliances used for cooking or space heating (Gas Council 1969, Elliot 1980).

Unlike domestic and commercial conversion, no standardised approach was taken across all the regional gas boards and a variety of conversion methods were taken. These ranged from using board staff to undertake the conversion, bringing in specialist contractors and using the plant manufacturers to undertake conversion. Even the regional gas boards that may have had a generalised approach found sites where alternative methods were required. Some customers were advised of what their new gas tariff would be and were left with the responsibility of organising their own conversion, with the logic being they knew their appliances better, especially those with unique combustion characteristics. In other regions, the gas board organised the conversion using their own workforce or contractors (Richardson 1977, Elliot 1980).

Apart from the few independent industrial gas networks, industrial conversions had to be undertaken with the corresponding domestic and commercial conversions that were supplied by the same gas main. These generally outweighed the number of industrial conversions. This led to a widely fluctuating workload for the industrial conversion department (Gas council 1969). The industrial sites located in a sector being converted could vary significantly and be quite resource hungry. This increased the importance of undertaking as much pre-conversion work as possible, so effort was minimised on conversion day (Elliot 1980).

Some regional gas boards, such as the WMGB, constructed spur mains to industrial areas from the NGTS in places such as Stoke on Trent to increase the rate of conversion of large industrial customers ahead of domestic conversions (Boost 1968a). A similar approach was taken by SoGB, which converted the Tunnel Cement Ltd. plant near Tring. This was expected to use more than 50 million therms (5.2 billion Megajoules) of gas, which was more than twice the gas consumption of Southampton at the time. The gas required to supply a single kiln was more than SoGB's industrial gas demand of the previous year. To supply the plant with natural gas, a new nine-mile long, 12-inch (305 mm) gas main was built jointly between SoGB and Tunnel Cement Ltd. (Figure 5.13) It connected the plant to a larger NGTS 24-inch (610mm) main at Weedon (Walker 1972).

Figure 5.13. The route of the purpose-built pipeline to the Tunnel Cement works at Pitstone in 1972. Source - National Gas Archive.

The Gas Council's Industrial Gas Committee at the time of conversion was chaired by Roy Hayman, who had been involved in the use of natural gas from early on. The committee was involved in the early industrial conversion projects and devised the 'Industrial Conversion Manual'. Collated by one of the committee members Walter Fitzsimons of the Gas Council, it contained procedures for converting standard items of industrial equipment by methods devised by the regional gas boards or manufacturers. The Industrial Conversion Advisory Committee was set up in March 1968 to advise on 'the collection of national requirements of industrial conversion equipment and material, the exchange of information gained from experience, and general operation aspects of industrial conversion' (Elliot 1986).

The committee compiled 'Notes for Guidance on Industrial Conversion', which was a general procedural background to the 'Industrial Conversion Manual.' (Elliot 1986).

Some industrial customers also had to be placed on LPG as a bridging measure where natural gas was not yet available. An example was the Cookson Antimony works, which were supplied by Northern Gas. Its conversion to LPG was carried out by Northern L.P. Gas Ltd., an associate company of Northern Gas, during the plant's annual summer shutdown. The LPG was mixed with air to give it the same Wobbe Index as natural gas. (Anon 1968).

5.7.1 The industrial conversion process

Early on, the conversion programme needed to decide on the method for industrial conversion. There were generally three main approaches employed:

- For a contractor to be employed to undertake the whole of the conversion from survey through procurement to installation.
- For the Board to survey and procure and for contractors to install.
- For the Board to survey, procure and install.

Which of these alternatives was used depended upon a wide variety of factors and combinations of the various possibilities that could provide the most satisfactory outcome.

Industrial customers were contacted nine months before conversion for permission to survey the premises. A team of two surveyors were usually dispatched and the survey would usually cover details of: meters and service governors, equipment manufacturer, information about the type of process, plant dimensions, the customer's identification number, equipment condition and output, accessibility, gas consumption and the usual operating hours.

Survey data was fed into data processing equipment for analysis and record purposes. Conversion produced masses of information, whether that was customer addresses, appliance models, survey data, financial data, marketing trend data from consumer surveys. It all needed processing by the administrative functions in the gas board, some of which was helped by early computers that could provide a print-out service. This was useful for producing items such as job cards for the conversion of each appliance and premises. Today, such data collection could be made much easier with the availability of computers, however an added complexity would be compliance with General Data Protection Regulation (GDPR).

System design engineers prepared detailed conversion schemes based on the survey information. This included documentation for each item of industrial plant requiring conversion, with clear instructions on how it was to be converted, whether pre-conversion can be carried out and what additional equipment will be required.

Customers were then informed, and the necessary procurements and allocation of duties were made. All conversion plans were constantly reviewed because of changes on premises between survey and conversion as due to plant reconfiguration. Close contact was kept with the customer in the run up to conversion.

To ensure conversion day ran as smoothly as possible, as much equipment as possible was pre-converted, which could vary from replacing existing burners with those of the universal type to renewing the brickwork around the burner ports on large heat treatment furnaces. To minimise inconvenience, these works were carried out during shutdown.

The regional gas board distribution engineers installed the necessary valves to enable the Distribution Network that was being sectorised before conversion. This was part of the same works as for domestic and commercial conversion. Six weeks before conversion day, engineers would build up their stock of conversion equipment.

5.7.2 Conversion day

On conversion day (C-Day), nominated Industrial Gas Engineer was put in charge of the industrial conversion activities for that sector. They were supported by a team of engineers and technical assistants and had a complete set of action files, containing all the working documents for the establishments and plant in the sector. Contractors turned off all industrial plant and equipment from 7.00 to 7.30 am onwards and attached a make-safe label to each item turned off. This stage had to be completed by 9 am and, from that time onwards, Board staff turned off all controls to customer supplies in the sector. The contractors' work force began conversion following make-safe and continued throughout all the other stages of the C-day procedure. The Conversion Mobile Control was notified as soon as all the customer controls were off and any gas flowing into the sector after 'gas off' was metered to prove the sector's soundness and to indicate whether any services had been missed in the planning stages (Gas Council 1969).

Once the sector soundness had been proven, natural gas was introduced and the town gas flared off at various points. When all the town gas had been purged out of the sector by the natural gas, regional gas board staff opened the customer controls for use as and when required. When the equipment had been converted for use with natural gas, the contractor's supervisor removed the make-safe label, verified the equipment had been satisfactorily converted and commissioned and attached a notice stating the equipment had been converted for use with natural gas. They then reported back to the Industrial Engineer-in-Charge. After conversion, regional gas board engineers were available to deal with any queries that arose and to ensure customers were completely happy with the new fuel (Gas Council 1969).

Standardised documentation and set procedures provided flexibility, enabling most snags and hold-ups to be handled on a routine basis and allowing a concentrated focus on any major problem. One such example occurred in Burton on Trent when a controlled flame steam boiler was discovered for the first time on a conversion day. The routine procedures going on elsewhere enabled Industrial Development Department staff to be freed iup to concentrate on the boiler and they soon arranged for immediate delivery of a suitable conversion set from the NTGB. On receipt, they installed and commissioned the boiler conversion equipment, thereby speedily solving the problem (Gas Council 1969).

5.7.3 Industrial conversion case studies

Two early industrial conversions were enabled by their proximity to the NGTS and the fact they were served by separate independent gas distribution systems isolated from the rest of the gas distribution network. The were the Mond Gas Network in the West Midlands and a distribution system serving the main industrial complex in Sheffield (Sharman 1968, Elliot 1980).

5.7.4 Mond gas system

The first industrial gas conversion to natural gas was the Mond gas network in the West Midlands, which only supplied industry. This network had originally supplied a low calorific gas called Mond gas, which had been discontinued in 1963 when the plant in Tipton that supplied it had been closed by the WMGB. The network was subsequently converted to town gas in 1963, so recent experience in understanding what was involved in converting that network existed (Appleby *et al* 1964, Elliot 1980).

One of the new natural gas transmission lines forming the new NGTS was planned to cross the Mond gas main and, in 1967, the WMGB decided to convert the main to natural gas with a supply taken from the NGTS (Sharman 1969).

By 1968, the Mond Gas network was supplying 32 factories within a 25 square mile area around Tipton, which equated to 7% of the base gas load in the WMGB. Detailed planning for conversion started 18 months before conversion day. At the beginning of 1967, the WMGB industrial gas department, which was acting as technical consultant, sent the Mond customers a list of the changes expected and how the conversion should be carried out.

Each engineer reported to a committee, which made the final decision on a recommended conversion procedure. Once the detailed investigations had been completed, equipment was ordered, and pre-conversion work started. By March 1968, more than 70% of the equipment had been pre-converted, with most of the remainder being left to conversion day to maintain production at the factories (Sharman 1969, Gas Council 1969).

The Board's Regional Distribution Engineer had headquarters in mobile offices in Tipton and kept in radio contact with eight local controllers and with the Smethwick offices, where the industrial engineers had their headquarters (Sharman 1969, Gas Council 1969).

The main conversion programme started on 26th July, when the industrial firms started their holidays and annual shutdown. Industrial gas engineers attended each of the companies to be converted. They checked all valves were closed and confirmed this to the mobile office. Natural gas was pumped into the system at Darlaston to drive out town gas, which was burnt off at 38 different flare stacks across the Mond system.

By midnight on the 26th, this part of the operation had been completed. Then followed the conversion within the factories, mainly changing the pressure rates and adjusting the gas/air inspirators for optimum burning. More than 100 engineers, chemists, radio operators and drivers were involved, and two mobile canteens toured the area supplying refreshments. In all, 618 appliances were converted either during the two weeks or in the pre-conversion programme. Alongside this, they changed some 2,938 burners, 624 sets of combustion and safeguard equipment and 689 governors and control valves (Sharman 1969, Gas Council 1969).

Unlike domestic conversion, the Mond Gas conversion was paid for by the customers, but their costs were recovered by reduced gas prices. Costs to the companies varied. For F. H. Lloyd and Co. Ltd, one of the largest users in the Mond system with an annual gas consumption of more than three million therms (316m MJ), the amount was £45,000. Allied Iron Founders, with five hand-held torches for conversion, had a total bill of £70 (Sharman 1969, Gas Council 1969). The Industrial customers on the Mond network were the first in the West Midlands area to use natural gas.

The regional gas boards benefited from the expertise available in the organisation on burning gases in various industrial appliances. In some large organisations such as the Birmingham Corporation Gas Department, this expertise was available before nationalisation, which developed these skills more widely and made them available across the regional gas boards (Elliot 1980).

5.7.5 Sheffield Industrial gas system

The availability of a supply of North Sea natural gas via feeder pipeline from Easington terminal enabled EMGB to prepare early for conversions in Sheffield. The Sheffield Industrial Gas system supplied 54 firms through a system of five medium pressure gas mains that originated from three of Sheffield's gasworks (See Figure 5.14).

Preliminary planning started in 1966, with the five mains reconfigured so they became a single interlinked medium pressure network that could be fed from natural gas off-takes at Effingham Street and Meadowhall gasworks. Some of the factories were also connected to the low-pressure mains for non-industrial gas use. These were blanked off and connected to the supply through the industrial gas main to avoid confusion and so they could be included in the conversion (Gas Council 1969a, Elliot 1980).

The pre-conversion surveys identified most of the industrial plant was supplied by just five companies: Priest Furnaces, Gibbons Brothers, British Furnaces, G.P. Wincott and Wellman Incandescent Furnace Co. These companies were approached to undertake the conversion under the supervision of the gas board engineers. The workforce consisted of 40 conversion engineers, which was expanded up to 200 when activity was at its highest (Gas Council 1969a).

The conversion took around 15 months and was characterised by large differences in the number of appliances requiring conversion. For example, one establishment converted on 11th April 1968 required 12 appliances converting, two of which were large process plant, while two weeks later, another establishment required 657 appliances converting, of which 237 were large process plant (Elliot 1980).

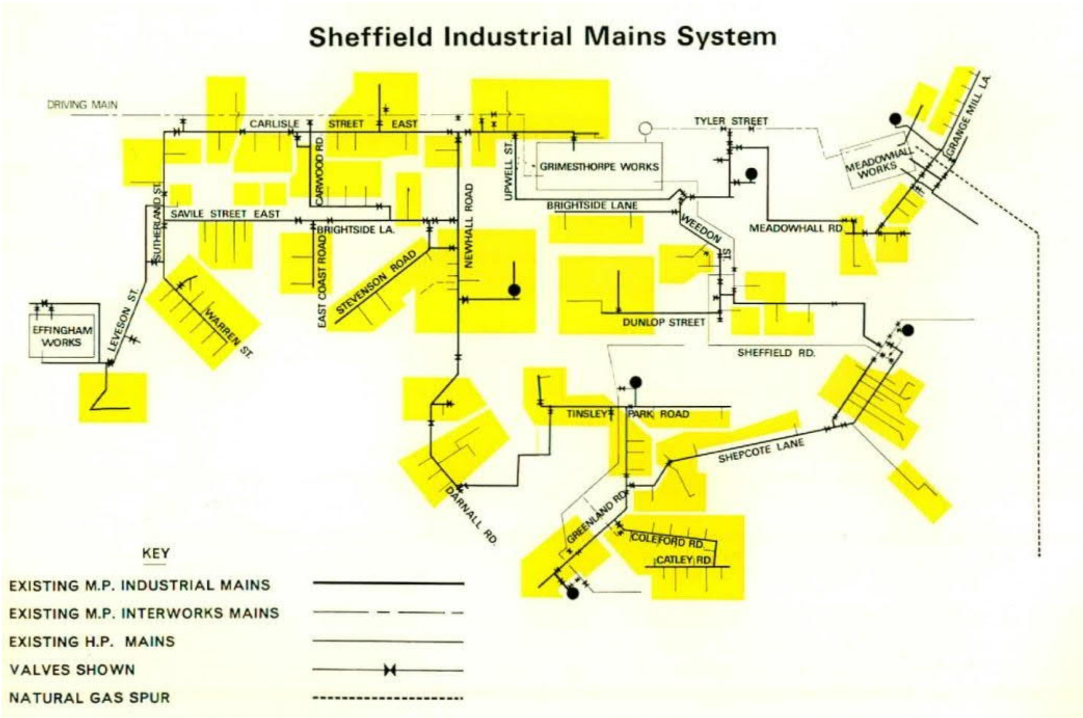


Figure 5.14. The Sheffield Industrial Gas System. Source - National Gas Archive.

5.7.6 Ford industrial gas conversion

Ford was the first major car manufacturer to switch to natural gas in Britain. The conversion of its plants at Dagenham and Basildon was a huge joint undertaking between the Ford Motor Company and NTGB. Ford was unusual in that it had its own coke ovens, producing surplus coke oven gas, which from 1935 was sold to the Gas Light and Coke Company. In 1963, the Gas Council laid a feeder main from the National Methane Pipeline, originating from Canvey Island to the Bromley by Bow and East Greenwich gasworks. The pipeline passed straight through the Dagenham Ford Works alongside the Tilbury railway line, so this was in theory a logical place to take a large supply.

Providing a supply was made more complex as the works had an agreement for the sale of coke oven gas to the NTGB and demand for natural gas was likely to be much greater than for town gas. With Gas Council approval, the NTGB was able to offer Ford natural gas from 1968 (Cameron *et al* 1969).

Surveys had shown the requirement to convert 721 appliances, of which 366 were process plant, 248 were appliances in the works' 12 canteens and 107 were space heaters, water heaters and tea making machines (Gas Council 1969).

The conversion was undertaken by Seaflame Conversion Ltd on behalf of Ford. It was split into two main aspects: 1) the conversion of the paint trim and assembly building, which used half of the works' gas supply and 2) the remainder of the works. Part 1 was undertaken over a weekend converting the 17 large processing ovens, while the second part happened over the three-week annual summer shutdown.

In some cases, specialist manufacturers were called in to convert their own plants. But the main difficulties were with equipment that could not be modified using existing sets. For these cases, Seaflame had to design and build prototype burners and test them in its own laboratory. The tight three-week schedule meant it was not possible to test them under operating conditions. All that could be done during the changeover period were minor adjustments.

This conversion was seen as large by any standards at the time. Mr. K. R. Eaves, the Contracts Manager of Seaflame's North Thames Industrial Conversion Unit, commented: *"The three-week deadline didn't leave any room for second thoughts. Nevertheless, the whole exercise went smoothly. And on this showing, I don't see why, with adequate preparation, conversion should cause any major problems for anyone."*

5.7.7 Birtley Estate conversion

The push to capture the industrial heating load by the gas industry was exemplified by a project undertaken by the NGB, when they had a chance to supply natural gas to an industrial district in an area not planned for conversion for a further four years. The industrial site at Birtley was supplied by a medium pressure gas main, which was converted in September 1971 solely for industrial loads. The Birtley Industrial Estate had been supplied by gas previously, but use was not extensive and there was a possibility of greatly increasing the number of units supplied with natural gas (Poole 1972).

The factories concerned in conversion were Armstrong Cork Co. Ltd (additional load from switching some electric radiants to natural gas), Caterpillar Tractor Co. Ltd, Durham Chemicals Ltd (big increase in load in switching additional plant from heavy oil), Royal Ordnance Factory; Crossley and Sons (converted from firing kilns on small coal) and Birtley Brick Co. (switched from coal and heavy oil to natural gas). To aid early conversion, the Birtley Brick Co. plant was first installed with a 50-tonne propane tank to supply propane air before natural gas became available (Poole 1972).

By accelerating the conversion of Birtley, the NGB increased the gas supplied from 1,599,000 therms/annum (168m MJ/annum) to nearly 16,200,000 therms/annum (1.7b MJ/annum) (Poole 1972)

5.7.8 West Midlands steelworks

Gas made up just 2% of the UK iron and steel industry's total fuel in 1966. This was expected to increase to the levels seen in the US (40%) with wider availability. By targeting this market, the WMGB believed it could double its industrial gas sales (Heliwell 1970). When a detailed assessment of energy load for the Round Oak Steel Works in Dudley was undertaken, it was noted the supply may need to increase from 17,000 ft^3/hr natural gas equivalent to 750,000 ft^3/hr natural gas (Heliwell 1970). Heliwell (1970) described the successful conversion of the Round Oak Steel Works depended upon: 1) one person being overall in charge 2) the requirement to undertake a lot of pre-conversion work 3) a timescale of 12-18 months (Round Oak was actually converted in seven to eight months) 4) a good long-term relationship between the regional gas board and the Industrial facility 5) efforts made to educate everyone from shop floor to boardroom about the process and 6) cooperation between the various departments of the regional gas board.

Mortimer (1971) found improvements in the operation of a converted billet reheating furnace at the London Steel Works in Warley, West Midlands. The conversion of the works had followed discussion with the WMGB and site owner the Duport Group in 1968, which persuaded the company major benefits could be achieved by conversion from oil only to dual fuel oil and natural gas. This led to joint feasibility studies and contract demand negotiations. Unlike a conversion from town gas to natural gas, conversion from oil to natural gas required more infrastructure investment and technical support to ensure the performance of the works. Contractors undertook the conversion of the furnaces and installation of pipework, meters and other works, whereas the WMGB ensured the gas supply to the premises (Mortimer 1971).

This conversion was regarded as a 'successful economic exercise to the mutual advantage of both parties', which increased gas demand and improved the works' performance (Mortimer 1971).

The introduction of natural gas enabled the gas industry to win over major industries, The biggest gas burning furnace in the West Midlands, which was at Stewarts and Lloyd's Bromford Works, was switched to natural gas in 1969, before most domestic customers in the region. It helped that the works were adjacent to the natural gas pipeline, which fed from the Coleshill NGTS offtake to the Washwood Heath gas reforming plant (Anon 1969b). This coincided with a big push by the gas industry to create a bigger presence in the commercial and industrial market in the West Midlands, which was driven by a 25% price cut, hoping to increase its share from 38m therms (4 billion MJ) to 120m therms (12.6 billion MJ) of a 400m therms (42 billion MJ) market (Anon 1969c).

5.8 The National Gas Transmission System

Today's National Gas Transmission System (NGTS) grew out of the National Methane Pipeline (NMP), which stretched from Canvey Island in Essex to Leeds in Yorkshire and was operational in mid-October 1964. The NMP was 200 miles long and had an additional 150 miles of branch lines, which connected the pipeline to off takes in eight of the regional gas boards. Initially, this gas was reformed to town gas before distribution. The NMP was completed within 25 months of the Minister of Powers' approval of the scheme in November 1961. It was the first pipeline built that connected the regional gas boards. As the Gas Council did not have executive powers, each regional gas board was responsible for building the part of the NMP within its boundaries to common agreed standards. (Copp et al 1966).

The natural gas in the NMP was supplied from the Canvey Island LNG import terminal, where it was stored as LNG in specialised tanks. The pressure and flow of gas within the NMP was supplied from the boil off (evaporation) of the natural gas from the LNG tanks at Canvey Island (Figure 5.15). The terminal was supplied by two British-built LNG tankers, Methane Princess and Methane Progress. These were constantly shuttling between the LNG export terminal at Port Arzew in Algeria and the LNG import terminal at Canvey Island.

The NMP was constructed of steel pipe, with the 200-mile section from Canvey Island to Leeds being 18" (457mm) in diameter. Branch pipelines of varying diameters were built from the NMP to: East Greenwich (SEGB), Bromley By Bow, Slough (NTGB), Reading (SoGB), Hitchin, Dunstable (EGB), Coleshill (WMGB), Sheffield (EMGB), Manchester (NWGB) and Leeds (NEGB). Four regional gas boards were not supplied from the NMP: WGB, SWGB, NGB and ScGB. The start of the branch line to Sheffield, which originated at Moscar in the Peak District, is shown in figure5.16.

Figure 5.15. Canvey Island Terminal with Methane Princess docked (top) and inside the Control Room (bottom). Source - National Gas Archive.

Research work was carried out dedicated to understanding the formation of hydrates in the pipeline. Hydrates are natural gas enclosed within a solid lattice of water molecules, which had been an issue with some early natural gas pipelines built in the USA.

The discovery of North Sea Gas changed how the NGTS developed, but the extension of the NMP towards a fully integrated national system was always regarded as an ultimate development plan. Canvey Island, previously the epicentre of the NMP, gradually lost its importance, although LNG imports continued (Walters 1970).

Figure 5.16. The Moscar site in the Pennines where a branch line fed Sheffield from the National Methane Pipeline. Source – Author.

The West Sole gas field was the first commercial gas field to be discovered in 1965, which led to the construction of a reception facility at Easington. Discovery of further gas fields off the coast of Norfolk (Leman Bank, Hewett and Indefatigable) led to the construction of the Bacton Terminal. To connect these terminals to the NMP, feeder pipelines were built. One went from Easington (1967) to Totley near Sheffield, where it joined the branch line of the NMP. Given the large amount of gas expected to be landed at Bacton (1968), two 36” feeders were built to London and another two to the Midlands. Later transmission pipelines were then built to convey natural gas to the four regional gas boards not initially connected to the NMP.

This system was extended and major alternative feeds provided to most other areas. Transmission pipelines were added to collect gas from onshore gas field at Lockton and further import terminal at Theadlethorpe (1972), St. Fergus (1977) and Barrow (1985). Unlike the original NMP, the NGTS required compressor stations to move the gas through the transmission pipelines, which used jet engines to provide the compression.

The natural gas from the geological strata below the North Sea was discovered at a very high pressure and was delivered to reception terminals, such as Bacton or Easington, via undersea pipelines. From these terminals, the processed gas was fed into the new feeder pipelines supplying the NGTS which was designed to transport the natural gas at a pressure of 1,000 Ib/in^3. From the NGTS, the gas was fed into the regional distribution systems via off-takes. The pressure would be progressively reduced as the gas passed through the various tiers of the gas distribution system, but it was expected to still be at an appreciable pressure when it arrived at the customer's premises. There were technical reasons for requiring higher pressures for natural gas rather than town gas. For example, it was needed within consumers’ appliances to draw sufficient air into the aerated burners. Since higher pressure was available, this requirement could be met quite readily, although it meant changes to governors and valves (Gas Council 1969).

Originally, the NMP was controlled from London by the National Controller of Methane (Figure 5.17 top) who worked for the Gas Council, with the control centre at Canvey Island (Figure5.15 bottom). The control room later moved to Hinkley (Figure 5.17 bottom).

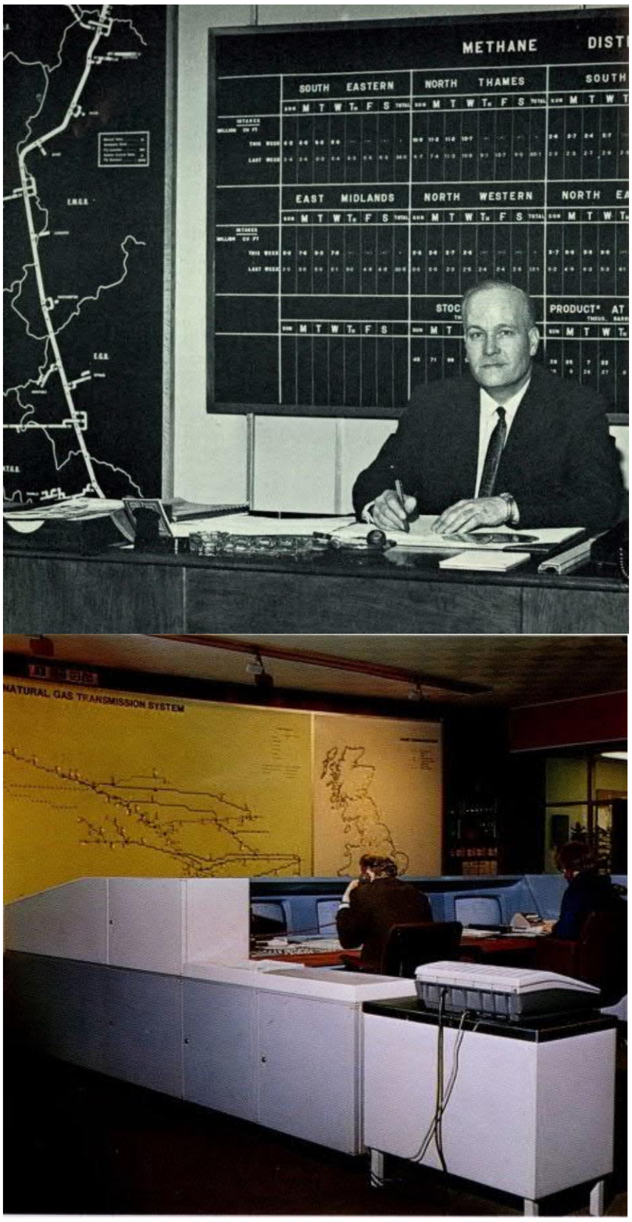


Figure 5.17 Ron Hildrew, the National Controller of Methane, in his London office (top) and the Hinkley Control centre for the National Gas Transmission System (bottom). Source - National Gas Archive.

Conversion was only possible with the construction of the NGTS as this was vital for the secure delivery of natural gas. The NGTS gradually grew from the NMP, a single pipeline, with short branch lines, delivering 10% of national gas demand to an integrated network supplying 100% of British Gas demand. Its evolution from 1966-1980 can be seen in Figure 5.18. As it evolved, the flow of gas through the network had to change. The most fundamental change being the St. Fergus Terminal in Scotland, which brought large amounts of gas from Scotland down to rest of Great Britain, requiring new transmission pipelines and compressor stations. It reversed the flow of gas in the north of Britain as the gas fields in Scotland came on stream.

5.9 Reconversion

Reconversion became an issue when customers moved from areas with natural gas to areas with town gas, taking converted appliances with them. Work was needed to restore a previously converted appliance for use on town gas (Byford *et al* 1977). Some regional gas boards produced their own reconversion instructions and provided parts, usually second hand recovered from the conversion operation, while others left the old parts in the empty set box should the customer move to a town gas area again (Byford *et al* 1977).

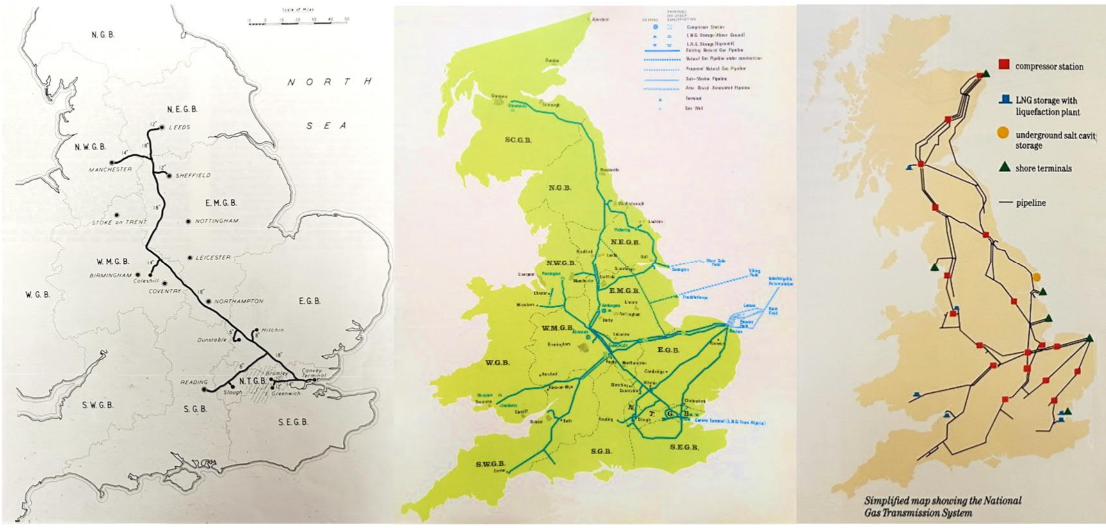


Figure 5.18. Three different maps showing the expansion of the NGTS, left 1966, middle 1971, right (c1980). Source - National Gas Archive.

5.10 British Gas Corporation

Halfway through the conversion programme, the Gas Act of 1972 created the British Gas Corporation (BGC), an amalgamation of the 12 regional gas boards and the activities of the Gas Council, on 1st January 1973. The regional gas boards became regions of the British Gas Corporation (Elliot 1980, Williams 1981). The BGC was given the responsibility 'to develop and maintain an efficient, co-ordinated and economical system of gas supply for Great Britain and to satisfy, so far as it is economical to do so, all reasonable demands for gas in Great Britain'. The corporation was empowered to determine the industry's operational structure and to exercise its responsibilities through the same 12 regions that had previously been the regional gas boards. Each region had a chairman and deputy chairman appointed by the BGC. As part of these powers, the BGC was also enabled to prospect for and produce natural gas (Elliot 1980, Peebles 1980)

The driver for creating of the BGC was the government's belief that the acquisition and distribution of North Sea natural gas needed to be done on a national level. They did not believe it was practicable at a regional gas board level as it could have otherwise led to competition between regions for supplies of gas if demand exceeded supply. The Gas Council had negotiated the supply of Algerian LNG imports and the North Sea gas contracts on behalf of the regional gas boards, but these were not powers enshrined in the Gas Council. Creating the BGC resolved these issues (Peebles 1980).
The 1972 Gas Act enabled the BGC to send officers to inspect gas installations and, if considered dangerous, they could cut off or refuse supply. It allowed some private competition and disallowed using profits produced in one part of the business to subsidise other parts of the business. The Act also formalised some historic arrangements between the regional gas boards and the Gas Council, enabling the conversion programme to run smoothly (Elliot 1980).

The British Gas Plant Operations Department became responsible for the operation of all terminals, storage plants and compressor stations that were to form part of the new National Transmission System. While some engineering capability had been developed in the Gas Council, following the formation of the British Gas Corporation, many functions were centralised. These centralised departments took on much of the design work for expansion of the NGTS, including the design of the import terminals, compressors stations and LNG storage and the construction of the pipelines themselves.
BGC also established a Construction Department in former NTGB offices in Paddington. The department undertook the tendering and provision of drawing documents for new infrastructure associated with the NGTS.

Figure 5.19The logo for the North Eastern Gas Region of the British Gas Corporation. Source - National Gas Archive.

Many gasholders were retained to continue providing diurnal storage (managing the fluctuations in gas demand between day and night). Longer-term storage had been envisaged at an early stage, using underground salt caverns or depleted gas fields. Both the Northern Gas Board and Northwestern Gas Board had used these, but they were not widely adopted. The future for storage was above-ground LNG storage, which the BGC constructed at Glen Mavis (Scotland), Dyvenor Arms (South Wales), Avonmouth (Bristol), Partington (Cheshire), Isle of Grain (Kent) and Ambergate (Derbyshire), locations where it was thought strategic supplies would be required. The Corporation also developed below ground storage later at Attick (Hornsea) in 1979 and offshore in the depleted rough gas field in 1985, which it had bought in 1980.

6. Regional conversion case studies

The number of customers that could be converted in one week depended on the labour force available on the conversion day, which varied between regional gas boards and over time. For example, the Northern Gas Board started with an initial 1,000 domestic customers being converted in one week, which increased to around 1,500 by 1970 (Hindmarsh 1970).

6.1 West Midlands conversion

The West Midlands Region converted 1,276,035 customers and 3,535,716 appliances within an eight-year period (Boost 1976). Conversion in the WMGB region started with a trial at Coleshill in mid-August, next to the offtake from the National Methane Pipeline. Coleshill was both a convenient location and presented a cross-section of domestic, commercial, and industrial conversion (Boost 1968).

Figure 6.1. The first (left) and last (right) flare points in the WMGB region at Coleshill and Erdington. Source - National Gas Archive.

The trial identified and addressed many difficulties, as described by the WMGB Conversion manager William Parsons: *“An awful lot of things had to be considered and that there was no substitute for actual experience in the field. And, although we are only part of the way through this pilot scheme at Coleshill, I think we have learned a great deal already. As a result, I am confident that the procedure for restoring customers supplies on C-Day will be considerably tightened up, and the delays which occurred in some parts of the first sector drastically cut in future sectors.”* (Boost 1968).

The biggest concern for the West Midlands was converting Birmingham city centre due to the high concentration of industrial and commercial premises. This would have led to too much work for the commercial and industrial conversion teams and too little for the domestic team.

The conversion planners developed a split sector approach, a mini sector in the city centre with enough work for a week was paired with a mostly domestic sector. At the programme’s height, 5,000 customers and 11,000 appliances were converted per week (Boost 1976).

Bromford Stores was built to support the programme, and, at its height, it stocked 200,000 conversion kits for 2,000 types of appliances, dispatching 120,000 each month. Storekeepers assembled the conversion kits into bags before dispatching to customers (Boost 1976).

Numerous unusual appliances also required conversion, including a Tangye Gas Engine in the Birmingham Science and Industry Museum (Boost 1975) and a 1937 New Herald range cooker that featured a gas fire, water boiler, hot plates, grill and oven (Boost 1973), both are shown in Figure 6.2.

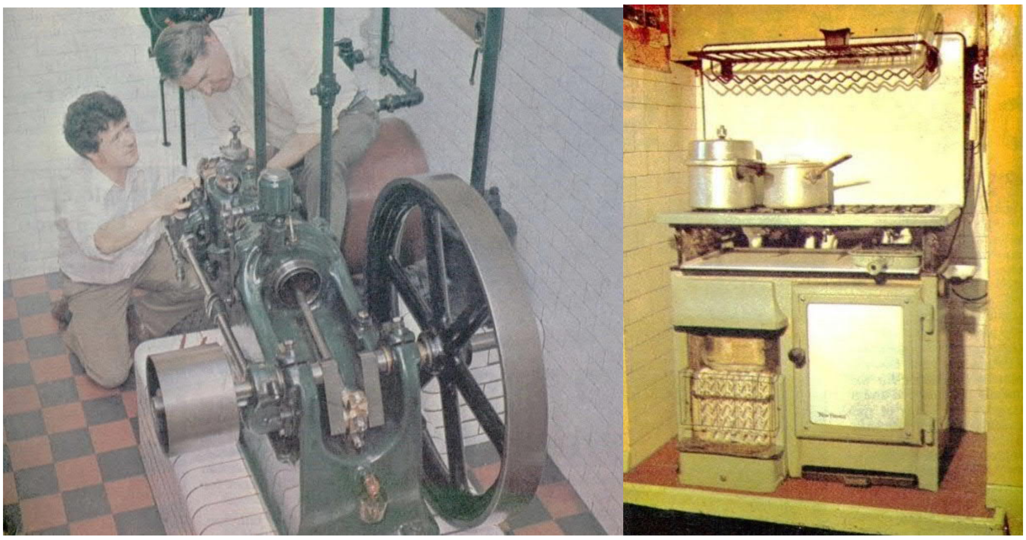


Figure 6.2. a Tangye gas engine(left) and New Herald range (right) requiring conversion. Source - National Gas Archive.

The last sector in the WMGB to be converted was Sector 821, which covered Erdington. The final town gas was flared off on 16th August 1976, almost eight years after the West Midlands region conversion started (Boost 1976).

6.2 Wales Gas conversion

Wales was the first region to be fully converted, a process completed in 1974. The conversion programme in Wales started on 14th April 1968 in Colwyn Bay, North Wales. North West and Mid Wales followed in 1969 and Monmouthshire, Pembrokeshire and Carmarthen were converted in 1970. The remainder of North Wales was converted in 1971, which led to the closure of the Maelor Gasworks and Newport. Cardiff was completed in 1972, the first capital city to be converted. The Rhymney and Rhondda Valleys and Swansea were converted in 1973, achieving 3,000 conversions per week. The programme ended in 1974 when Neath, Port Talbot, Porthcawl, Bridgend and the Garw and Ogmore Valleys were converted, leading to the end of gas production at the E.M. Edwards gasworks at Llandarcy on 18th April. (Wales Gas1974)

Wales was fed by two major natural gas pipelines. North and Mid Wales were fed byone that terminated at Maelor gasworks, Wrexham, and South Wales was fed from a pipeline that stretched from Wormington to Llandarcy, the latter passing over mountainous terrain up to 2,000 feet (700 metres) in height. Once these pipelines were in place, conversion became possible (Scott 1969, Scott 1970, Wales Gas 1974).

Wales Gas Board (WGB) assembled a conversion task force in 1968. The Board's Operations Research Scientist oversaw the programme, which cost £22 million. WGB planned and controlled the conversion, deciding how best to split the country over a seven-year timeline. It had to consider the availability of gas to meet future demands, the capacity of the grid systems and the existing contracts for the bulk supply of towns gas and feedstocks from the National Coal Board (coal and mines gas) and the British Steel (coke oven gas). These external gases had been a significant proportion of supply, so phasing them out had to be done carefully. The impact was to remove what had been lucrative contracts from the NCB and steel companies, adversely affecting those businesses. (Scott 1969, Scott 1970, Wales Gas 1974).

The main reforming plant at Maelor switched to reforming town gas from natural gas in March 1969. The NCB mines gas contract for the Point of Ayr ceased on 16th April 1969, with the similar Bersham mine contract ceasing soon after. The reception and purification of coke oven gas from Shotton Steel works ended on 24th March 1971. The remaining high-pressure reforming plants were shut down in April 1971, leaving only a Catalytic Rich Gas plant to provide the remaining town gas load in North Wales until conversion was complete in June 1971.

In South Wales, Newport was the first area to be converted. It has been supplied with town gas by the Bedwas coke ovens and this contract ended in 1971. Subsequently, its coke oven gas supply from the Guest, Keen and Nettlefold Steelworks ended in November 1972 and the gas plant at Grangetown Cardiff that supplied peak load also closed, with the exception of its LPG plant that could be used in emergencies.

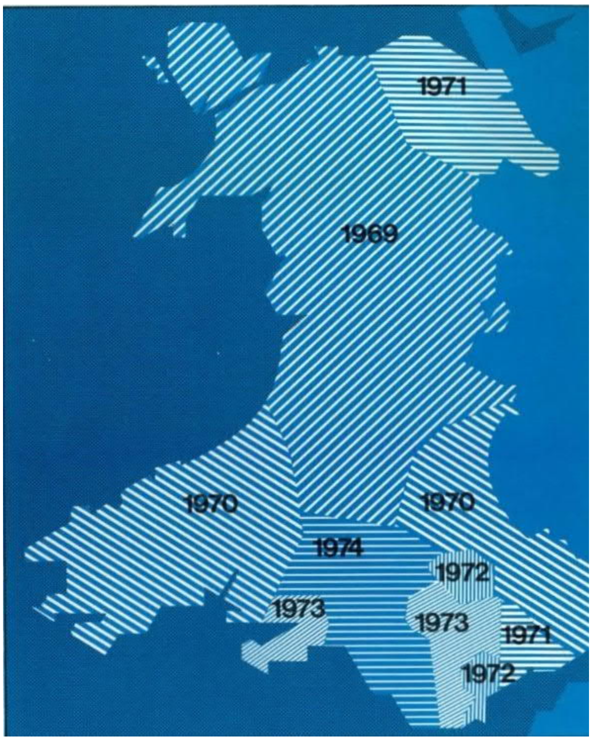


Figure 6.3 A pictorial representation of the conversion programme in Wales (Wales Gas 1974). Source - National Gas Archive.

Sectors were designed to hold an equivalent workload and varied significantly, from rural sectors of more than 60 square miles to less than a square mile in city centres (Wales Gas 1976). Each customer was visited, and more than 8,500 appliances were recorded, including a gas lighthouse and a gas-powered radio set. Newly developing computers were also being used to store process and produce information (Scott 1970, Wales Gas 1974). The conversion was undertaken by an independent contractor, Turriff Ltd, who were said to have been the first contractors to undertake conversions in the UK (Wales Gas 1974).

WGB adopted two-stage conversion principles on the original conversion programme in North West Wales and Mid Wales. This first phase was completed a few weeks before the arrival of natural gas. Issues arose due to increased demand for gas in the winter of 1969-70, the geography and nature of the area to be converted (which covered some 5,800 square miles) and the volume of LNG needed for temporary supplies during the conversion. The conversion team in Wales made extensive use of mobile LNG plants that were supplied by the British Oxygen Company (BOC). (Scott 1969, Scott 1970).

The WGB undertook a massive pre-conversion appliance programme, simultaneously training personnel in the administrative techniques and the practical skills of conversion. It aimed to reduce the workload on conversion day, allowing the conversion to proceed at a higher rate. Work to fit governors and filters was planned in July 1968 and pre-conversion work was scheduled in September 1968.

This exercise attempted to convert 50,000 consumers in a 31-week period, from the receipt of North Sea gas on 14th April 1969 until 10th November 1969. The work force needed to convert 6,000 appliances per week, with a maximum of 8,800 per week. The conversion field unit, which included 200 vehicles, had to be moved each weekend, leaving the previous sector to deal with outstanding conversions and complaints. At its peak, the conversion sector was 35 miles long with a total sector length of 160 miles, covering an eight-week post conversion call-back period (Scott 1969, Scott 1970).

The programme faced problems from the outset. Six weeks after starting pre-conversion works, a labour dispute with the fitters almost brought things to a halt and later restricted timelines. Conversion sets were limited and gas boards undertaking conversion were given priority over those in pre-conversion. The aim was to convert 50% of appliances, but only 30% were pre-converted.

When the conversion work started in April 1969, another labour issue arose. Of the 360 fitters available for the programme, 94 had left their job the week before. This meant having to divide areas planned for conversion into smaller sectors, created a backlog of 3,000 jobs and required a three-week extension, pushing the programme into peak holiday season. Staff also had to be drafted in to deal with some of the complex commercial catering equipment (Scott 1969, Scott 1970). This had a negative impact on conversion cycle workload and customer inconvenience increased, which nearly doubled costs.

Scott (1970) concluded: *"The conversion exercise is one that demands the strictest day-to-day control of technical standards and administrative procedures. It is a continuous battle to make people follow the instructions laid down. The problem of over-changing personnel does not help. If we are to improve, and improve we must, the manufacturers must provide better designed conversion sets with simpler instructions. We ourselves must find ways and means of retaining the people on conversion who have attained a high level of skill."*

6.3 Southern Gas Board

Conversion within the SoGB started at Bletchley on 31st May 1968 and ended in Reading on 3rd February 1975 and was the second shortest after the WGB. SoGB were one of the two gas boards to undertake conversion in-house without contractors. Because they recruited a conversion team, the Board's Training and Education and Personnel departments were heavily involved. As a testament to the staff recruited, more than 120 of the original conversion personnel recruited in late 1967 and early 1968 were still working for the Board on completion of the conversion in February 1975.

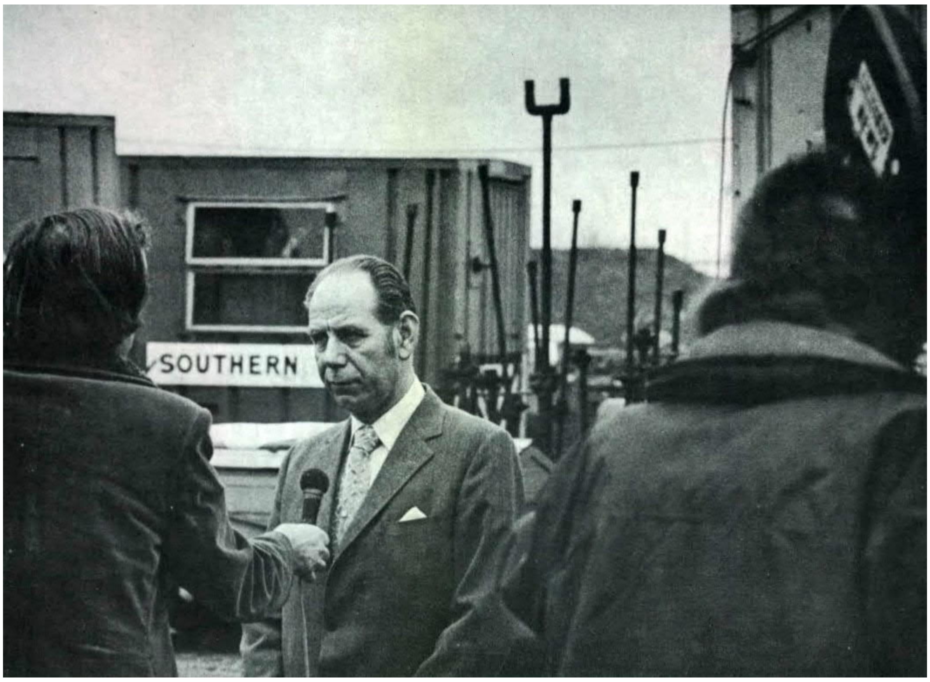


Figure 6.4 Gerry Taylor, the Conversion Manager of Southern Gas, being interviewed on the last day of the conversion programme on 3rd February 1975 in Reading.

Flame Gas magazine published a retrospective piece on completion in February 1975 (Walker and Sutherland 1975). It reported that Gerry Taylor started his career as part of the SoGB programme and ended as conversion manager. When he first went to Reading in 1967 to set up the conversion workshops, there was a bench in a room and nothing else. The training centre was nothing more than a dumping ground for old cooker spares, which it took four weekends to clear. Eventually, with support, Gerry established the workshop, laboratory, and stores. The transport department designed field-based workshops, mobile workshops, and crew buses. Gerry worked with the Training and

Education and Personnel departments to recruit and train conversion fitters (Walker and Sutherland 1975).

That first sector the SoGB tackled in Bletchley was mainly industrial and commercial customers – there was only one domestic customer in it – but the second sector was primarily domestic customers. “It was a week of uncertainty, knowing that we could upset a lot of customers,” said Gerry Taylor. “At the time, I wondered if we were being brave or foolish.” There were problems: inexperience, incorrect surveys, conversion sets broken and customer resistance to the change. "People in those days just didn’t see the necessity of it,” added Gerry. “But with the problems came the answers, often painstakingly worked out in workshop and laboratory and, as one issue was solved, another took its place.” (Walker and Sutherland 1975).

Figure 6.5. Metering in gas (left) and flaring of gas during ‘Turn out' in the SoGB Region. Source - National Gas Archive.

Other challenges faced by Gerry included the need to go back and modify the conversions of 4,000 central heating boilers and converting a sector of 7,000 customers over two weeks on the Isle of Wight. One customer at Bordon, Hampshire, who wanted nothing to do with natural gas confronted the conversion engineer with a shotgun. They quickly moved on and did not return until the person in question had been persuaded to change his mind and put away his gun. Derek Frost, an engineer who had joined at the start of conversion and moved to post conversion call-back, highlighted: *“The job got* *much easier as converters became experts at their job. They dug deeper into problems and picked up things not directly concerned with conversion"* (Walker and Sutherland 1975).

Many who worked on the Southern Gas conversion echoed the same thoughts. They enjoyed the changing scenery as they moved around the region, the informality of the job, the ever-changing technical challenges, problem solving and chance to use their initiative. For some, it had been the first time they had properly been away from home and was viewed as a chance to make new friends. One thing they did not miss was all the driving, with one engineer calculating they had driven 177,000 miles during the seven years of the conversion programme. One clerk working on conversion thought it attracted a particular kind of person – somebody who wanted something different out of life. *"If that's not true, then the job has changed the people who came into it"* (Walker and Sutherland 1975).

Gerry Taylor said: "*To start with, we would never have done the job without 100 per cent cooperation from our customers. After all, they had often gained a bad impression of conversion from the press, and we were going into their homes uninvited to give them a new gas when they were quite happy with the old*." But co-operate customers did. And so did everybody else connected with the job. Gerry went on to say: "*Whenever we have asked for any special effort, we have got it. People have worked long hours, travelled great distances, been abused by customers, and still done the job*" (Walker and Sutherland 1975).

Mr Taylor emphasised such feats could not be achieved without the willing help given by the whole conversion team, distribution, stores, transport, administration, field force and customers. He also highlighted the tolerance of top management towards the problems and their solutions as well as the spirit with which everybody had tackled the job and shown that, brave or foolish, they could finish it successfully (Walker and Sutherland 1975).

6.4 South Western Gas Board - Cornwall and isolated conversions

Remote towns in the South Western Gas Board proved a challenge for conversion due to their isolated location at the end of the SWGB distribution grid, often with only one gas main supplying the town. Several options were considered, including supplying natural gas to customers in the form of re-gasified Liquified Natural Gas (LNG) or installing a temporary above-ground gas main. The latter option had been tried in Yeovil, but deemed unsatisfactory and was not used elsewhere. The use of LNG was deemed unviable as there was no available source of LNG in close enough proximity. The SWGB opted instead for a propane/air mixture compatible with natural gas, otherwise known as

Synthetic Natural Gas (SNG), as a temporary supply for several weeks. This approach had been used in Germany as part of its conversion programme and Hellendoorn (1967) had suggested its use in Britain.

A successful trial conversion was undertaken at Minehead using a propane/air mixing unit hired from the British Oxygen Company (BOC). BOC operated the plant, while a SWGB chemist ensured the correct gas quality (calorific value and Wobbe number) was supplied. Conversion took two weeks, the first week involving converting Minehead via a low-pressure supply from the gasholder in the town while the second week saw the villages of Dunster and Williton supplied by a medium pressure main directly from the plant. Once converted, the area could then be supplied with natural gas from the SWGB natural gas grid as it advanced through the region (Bennett *et al* 1974).

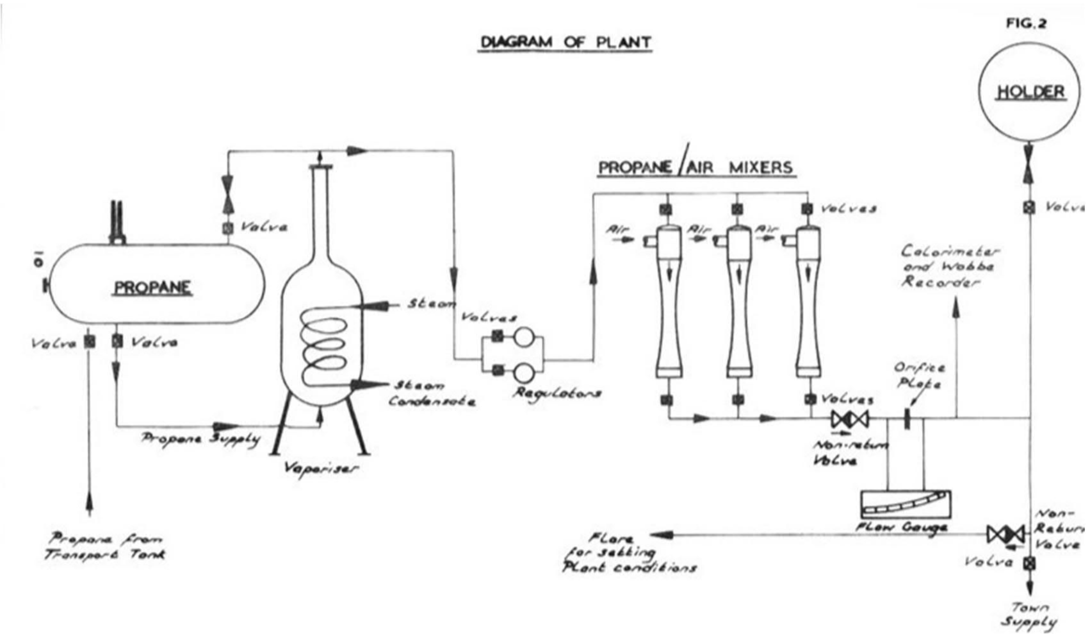


Figure 6.6 The schematic of the propane/air plant devised by SWGB for use at Ilfracombe and other towns. Source - National Gas Archive.

Despite its success, the trial was expensive due to plant hire. As a result, SWGB constructed a new plant using its former butane/air vaporiser and surplus propane tanks.

This design (Figure 6.6) was used in the conversion of Ilfracombe, Bideford, Marlborough, Tiverton, Brixham and Dartmouth. Temporary facilities were constructed at each location for the plant to be housed and controlled, all supplied by the SWGB and tested before use in conversion. Propane was delivered by lorry from a supply kept at a temporary railhead. The plant moved from town to town, converting a total of 18,000 customers from town gas to natural gas (Bennett *et al* 1974).

With roughly twice the number of customers to be converted in Cornwall, the propane/air approach proved to be a much larger undertaking than initially thought. Propane/air plants were constructed at Penzance and Truro and a mobile plant moved between St. Ives, Falmouth, and Newquay. On its own, the plant at Truro met just half the maximum daily demand, however, when buffered by the 750,000 ft^3 low pressure gasholder, it met all demand, with the gasholder refilled when demand dropped. Low pressure gasholders were used at all the sites being converted as a buffer for storing propane/air.

SWGB supplied most of the plant, with a new vaporiser purchased and a 50-tonne propane tank supplied by another regional gas board. Propane was delivered to Penzance by rail and transferred to the plant by road tanker. The programme started in April and finished in mid-July, at the start of the holiday season. Newquay was later converted during the Whitsun holiday.

Despite the different properties of propane/air, only one major incident occurred when a solenoid valve failed at Truro, which required the plant to be operated manually. This was quickly resolved with no loss of gas supply. Minimal further adjustment of appliances (removal of air slides on 67 appliances) was required when the Synthetic Natural Gas (SNG) was replaced by natural gas (Bennett *et al* 1974).

The Cornwall conversion took 14 weeks, by the end of which 29,000 customers were being supplied with 1.8m $cuft^3$ of gas per day, natural gas replacing the temporary supplies of propane/air gas (Bennett *et al* 1974).

6.5 North Thames Gas Board – early conversion challenges and the conversion of central London

The NTGB was one of the more challenging areas to convert. While the 1966 pilot trial at Canvey Island was at the eastern extremity of the Board’s supply, conversion here started later than in some other areas due to its distance from the North Sea natural gas supply.

Detailed planning started in 1968, with conversion starting in April 1969 (Conversion Unit 2) and finishing at Beckton gasworks on 23rd August 1976. The eight-year programme converted 5,164,256 appliances in 1,908,000 premises (Anon 1977b).

The NTGB faced some early challenges in its conversion programme. It was forced to stop the conversion programme in January 1969 due to the high level of call back. During the stoppage, the NTGB overhauled conversion procedures and techniques with the hope this would provide improved service to customers.

One adjustment made when conversion operations resumed was a reduction in the number of conversions from 4,000 to 800 premises a week due to the potential for severe weather during the winter. The reason was to help deal with call back and to keep the volume of work within manageable limits. The intention, however, was to resume the higher rate of conversion once the weather was better and things were running more smoothly (Anon 1969e).

Customer service in the post-conversion period also improved, with special teams being assigned to each conversion area to deal with faults and queries. The NTGB also made it easier for customers to report faults so they could be dealt with promptly. In each conversion area, the Board set up a Mobile Report Centre to enable customers to call in and discuss their problems personally alongside its postal and telephone options. The conversion pause was also used to give further instruction to fitters and to increase the training period, while the Board built up its stocks of conversion kits as there had been shortages of some types during the previous conversion period. Priority was given for cookers, even if only for simmering and some form of heating (Anon 1969e).

Central London was the last area to be converted due to its complexity and density, taking on learning from less-populated outlying areas. Conversion took three years, starting on 3rd September 1973 at Kentish Town (NW5) and finishing on 23rd August 1976 at Becton (E6). The conversion was undertaken by a specialist team of 80 conversion fitters and 40 assistants as it included some of the most complex and sensitive sites, including Buckingham Palace and the Palace of Westminster. This is described in detail by Rhodes *et al* (1974) and Collins and Green (1977).

The conversion of central London was the most demanding for commercial conversions. Planning started in 1970, 3.5 years before the first sector was converted.

The programme started in Kentish Town in September 1973 and ran smoothly. Issues arose when the conversion moved to Park Lane in summer 1974 due to the volume and condition of commercial appliances. This phase also coincided with the three-day working week. More stringent preparations were made before tackling Westminster in 1975. The pre-conversion programme was extended, the team increased, and the three-day week ended. Around 2,000 commercial appliances were converted per month, with peaks of 6,000 in July 1974, and 5,000 in October 1975 (Collins and Greene 1977).

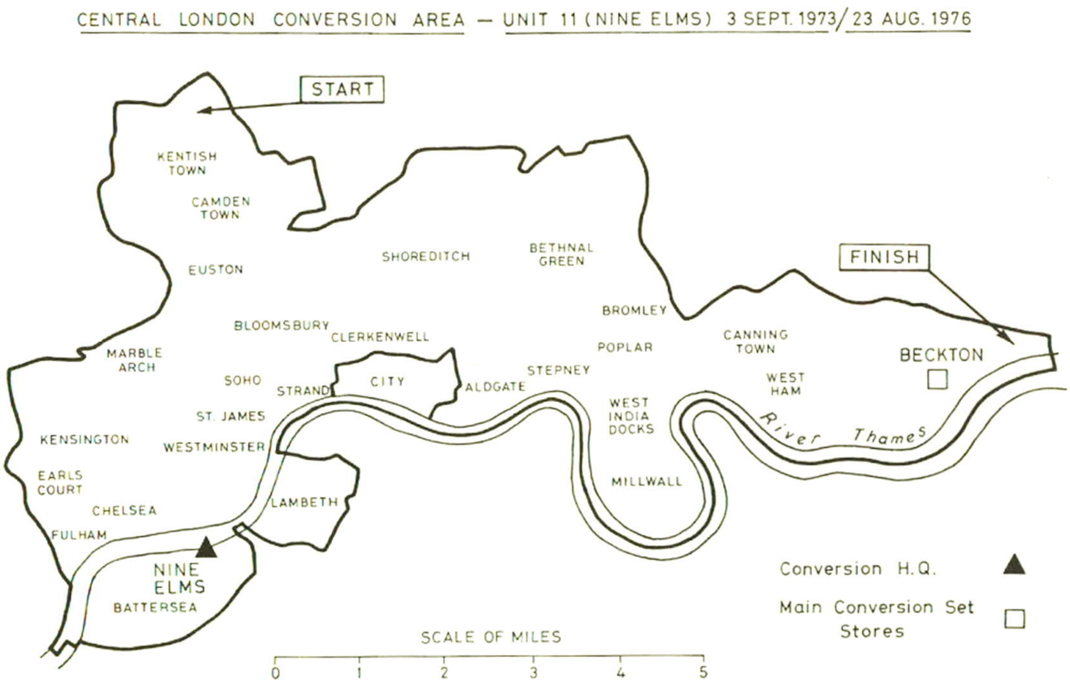


Figure 6.7 A map of the central London conversion area. Source - National Gas Archive.

In many cases, the conversion of the catering equipment improved its performance, a service later offered by British Gas. Collins and Green (1977) remarked that many appliances were ‘more than just converted, and many an old catering appliance found in a most dilapidated condition now has a new lease of life – and a satisfied owner.’

Another key consideration for central London was accessing sensitive sites, such as government offices and the Royal Residences. The conversion period coincided with increased terrorist activities by the IRA. Staff were granted security clearance and the project progressed due to unwavering cooperation. Sites of national importance, such as London Hospital, were converted by a Special Projects team of 14 highly qualified fitters. Some sites were converted out-of-season, such as Buckingham Palace when the Royal Family was away and the Palace of Westminster during the Summer Recess of 1975 (Collins and Greene 1977).

The city of London posed a much bigger communications challenge than the rural areas where the NTGB had started. In the more rural areas such as Basildon, the focal points of interest for public relations were clearly defined. There was the local authority, one or two big businesses, the well-supported local organisations, rate payers' association, chamber of commerce, women's organisations, and welfare societies. In general terms, most NTGB customers were much more committed in their attitude to these organisations and to the community. Few had been influenced by previous experiences recounted by friends, relatives, and journalists.

Figure 6.8 Flaring off gas from Westminster Bridge during 'Turn in' and the completion of the central London conversion at Beckton Gasworks. Source - National Gas Archive.

In central London, the population was much more diverse and mobile. Moreover, large areas of the population seemed to have few links to any local organisations. All had been subjected to a barrage of adverse comments about conversion experience over many years. Formal presentations were not nearly as successful as was the case in outlying areas. The pre-conversion public meetings, exhibitions and talks were arranged, but in central London were often met with only a limited response. An increasingly higher proportion of customers in sectors were not getting the NTGB's messages despite its hardest endeavours and while public relations continued to be successful in the important key areas, the blunt fact was that it was becoming more difficult to get customers even remotely interested let alone concerned about conversion. The result was that the Board found itself spending more time on post-conversion public relations problems rather than pre-conversion.

6.6 Scottish Gas Board

Conversion in Scotland started slightly later, kicking off in the border town of Kelso on 15th June 1970. This was due to the need to extend the NGTS into the country. Scotland had been split into 510 sectors covering 383 cities, towns, and villages. Of these, only Edinburgh, Glasgow, Dundee, and Aberdeen had a permanent conversion base established, with mobile units used across the rest of the country for four-week periods. Conversions on the field were undertaken by contractor William Press & Co Ltd, requiring 997 personnel and 400 vehicles (Anon 1977, Prentice 1977).

Figure 6.9 Sam Paterson, The Scottish Gas Conversion Manager (left) and George Robertson of the contractor William Press (right). Source - National Gas Archive.

Conversion headquarters were based in Edinburgh and was responsible for all planning, administration, and technical services essential to the complex operation. The natural gas conversion base was at Kirkintilloch, where all the customer records and inquiries were handled. Initially, only a single field team was used, but they were joined by a second in 1975 during the Glasgow and Edinburgh conversion.

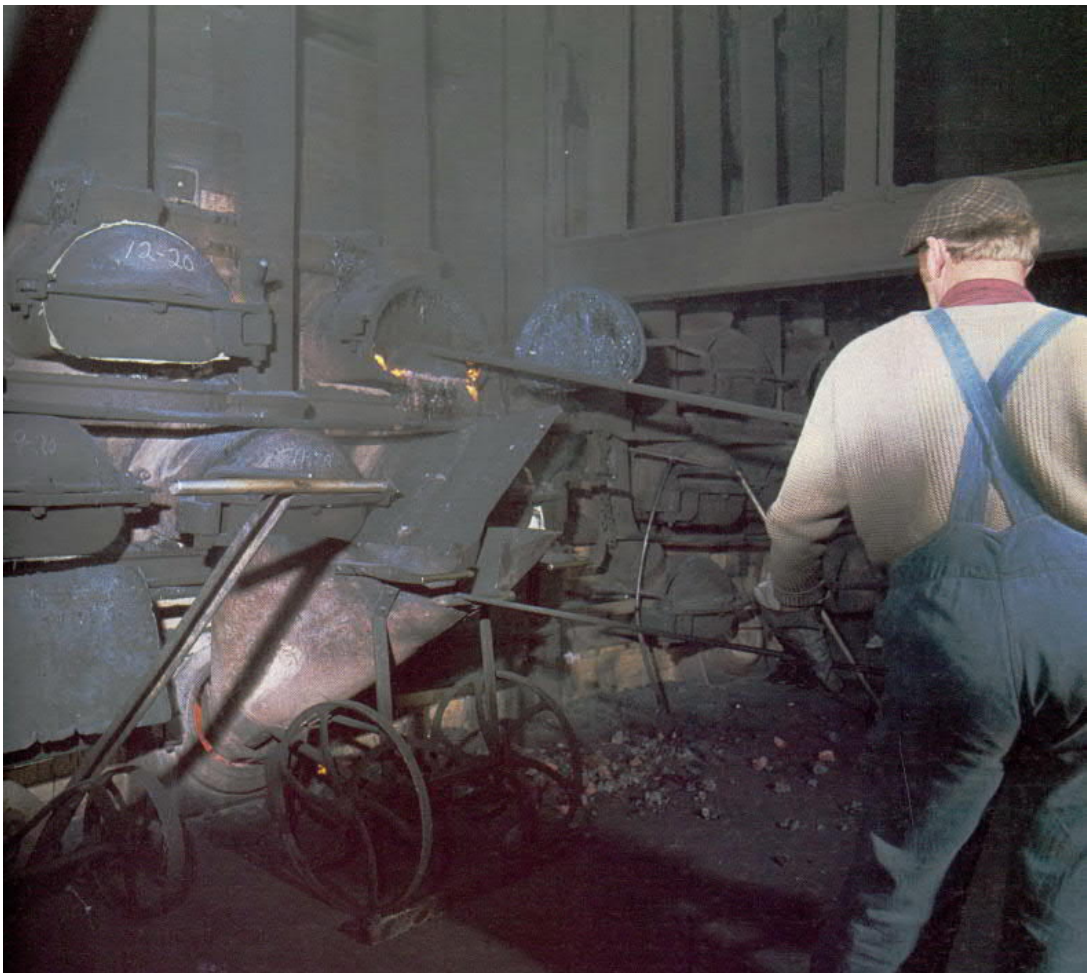


Figure 6.10. A stoker emptying coke from the last gasworks to close on the mainland gas network at Muirkirk (Right). Source - National Gas Archive.

Scotland was home to many isolated and rural gas undertakings that had produced coal gas, but it was not viable to construct a pipeline to supply natural gas from the gas network. The ScGB offered four alternatives;

- The reforming of light distillate
- The use of neat Liquid Petroleum Gas (LPG)
- The use of LPG/Air
- The supply of Liquified Natural Gas (LNG).

The first option could be used without converting appliances but was only appropriate for larger sites due to the plant required. All the other options required some form of conversion or appliance replacement. The most popular were the use of LPG/Air and LNG. The northerly towns of Wick and Thurso were converted to LPG/Air initially in 1969 but were later converted to LNG in 1982. Dunnoon, Campbeltown and Rothesay were switched to LNG. The distributed gas supply of some gas undertakings such as Golspie, Inveraray and Millport were given up and the customers offered ScGB branded 'Glogas', which was bottled LGP instead.

By the end of the operation, 817,100 domestic, 20,700 commercial and 3,000 industrial customers had been converted.

Field operations manager John Young remarked: *"During conversion, we experienced some trying times but on the other hand there have been the brighter moments which kept people's spirits up."* Sam Patterson, conversion manager for Scotland, commented: "*It has been a long hard job and it will be a pity to see the team split up shortly. Everyone has pulled together and worked hard to overcome the difficulties and complete the job of converting over two million appliances in Scotland*" (Prentice 1977, Elliot 1980).

7. Safety and regulatory influences on the conversion programme

Safety and standards had a big impact on the conversion program. The project shone a light across the country's gas infrastructure, most significantly in customers' properties, where standards of gas fitting sometimes fell short. This was the first time in history a deep dive into the condition of every single gas appliance was undertaken – appliances, pipework and meters were inspected to ensure their suitability for conversion, with any defects noted.

These surveys brought to light the poor standards of maintenance in which much gas equipment was kept, not only in domestic premises but also in commercial properties such as railway stations. Some of the equipment discovered in the homes of customers were described as 'museum pieces' and were unsafe to use. Examples of such appliances are shown in Figure 7.1. As Kidman (1970) highlighted: *"The biggest problem is getting parts for old appliances. Many are obsolete and spares not available. Many have been neglected; they can be rickety, filthy and, at times, downright dangerous. They all must be converted, or a replacement provided (Kidman 1970)."*

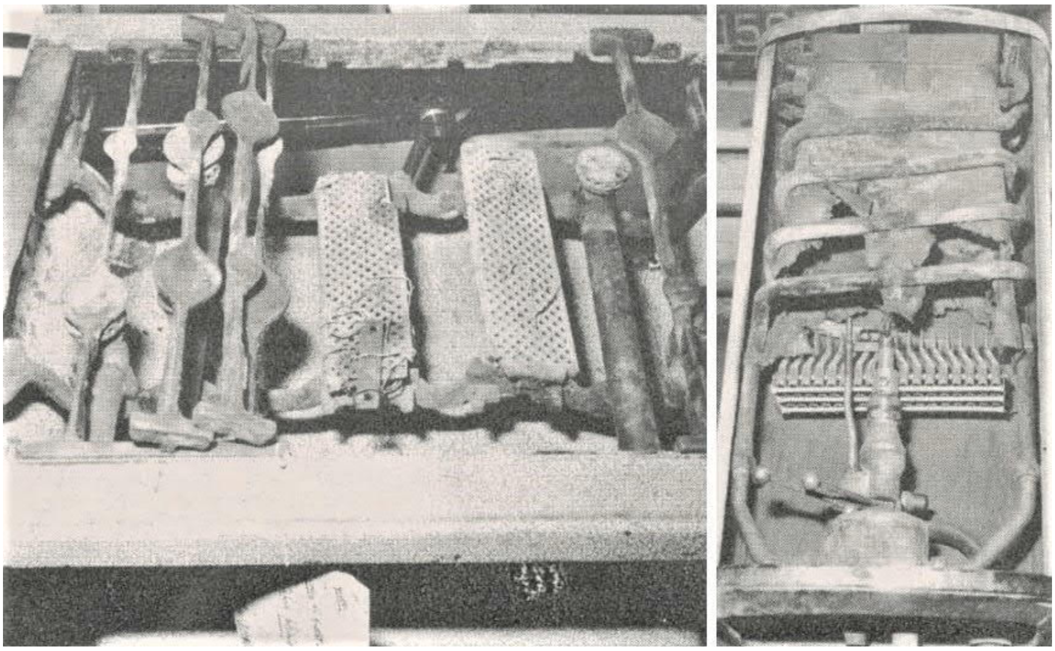


Figure 7.1 Obsolete appliances recovered from customers' homes. Source - National Gas Archive.

This preparatory work was greater and more costly than predicted. Surveys highlighted the need for remedial action such as cleaning blockages from pipework and replacing broken radiants as well as more serious issues such as appliances installed in contravention of building regulations. The conversion programme had been promoted as free to customers; however, customers were expected to pay the cost of remedying defects. This was a difficult and unpopular policy decision, especially where customers had claimed appliances were in good working order or where safety standards had tightened since installation. Some discretion was applied by gas boards, especially for customers in hardship, where they would cover costs in part or in full (Elliot 1980).

The question of natural gas safety arose through public reaction and was aggravated by the media (Elliot 1980). An article by the senior Public Relations Officer for the WMGB, Bill Kidman, highlights media headlines at the time, which included: “Killers in the Kitchen”; “MP Concerned over natural gas Bills”; “Gas Conversion Still Leaves Family Cold”; “High Speed Heating Headache”; “Hold-Up Hits 400”; “High Speed Washout”; “’We Won’t Pay’- Gas Conversion Victims”; “Life is so unnatural with natural gas”; and “The on-off story of a converted gas fire” (Kidman 1970).

Between 1969 and 1970, questions were being raised over the safety of natural gas and the way in which the conversion was carried out. Customers were concerned by noise from gas appliances, especially fires, and worried some pilot lights or ignition systems did not work well on natural gas. Call back rates also reached a peak of 25% at this time, further exacerbating the issue, with attention turning to MPs and other policymakers. (Elliot 1980).

The conversion highlighted issues the industry had faced for some time and helped accelerate work to improve ignitions, particularly on cookers and fires. It also improved simmering on hot plates (Elliot 1980). New safety measures were also incorporated, such as flame failure devices in cooker ovens, banning portable heaters and using only balanced flues for water heaters used in bathrooms (Elliot 1980).

Regional gas boards pushed the safety case for natural gas over town gas through the reduction in deaths due to gas. Kidman (1970) of the WMGB claimed gas was safer as the number of deaths due to gas fell from 1,193 in 1963 to 369 in 1968. These deaths were largely due to asphyxiation by the carbon monoxide in unburnt gas and the switch in gas manufacturing from coal to reforming plants had reduced the carbon monoxide content in the gas down to 3%. The switch to natural gas removed this toxic component from the unburnt gas altogether.

Public anxieties about the safety of natural gas led to two major independent inquiries. The first was the Morton Report, or ‘Enquiry into Public Concern which had Arisen in

Conjunction with Conversion of Domestic Appliances to Burn Natural Gas.' It was prepared by Professor Frank Morton of the Department of Chemical Engineering at the University of Manchester in 1970. His terms of reference were "Inquire into the safety of natural gas as a fuel" on behalf of the Paymaster General, Harold Lever, who set up the inquiry.

The Morton Report was welcomed by the Gas Industry. Sir Henry Jones, Chairman of the Gas Council, stated: *"In a most exhaustive and comprehensive report, Prof. Morton largely vindicates the view of the gas industry that natural gas is a very safe domestic fuel."* (The Yorker 1970).

Sir Henry underlined three aspects of the Morton Report. Firstly, that the inquiry concluded the risk of explosion and fire was no greater with natural than with manufactured gas. *"It says that, as a result of the conversion operation, the systems by which gas is distributed, the premises in which gas is consumed and the appliances in which gas is burnt should be safer after the conversion operation has been completed than before,"* he said (The Yorker 1970).

Sir Henry's second point concerned ignition: *"I can say that the gas industry has taken serious note of the inquiry's findings that 'one area of complaint' which appears justified is the behaviour of pilot lights, flash tubes and electrical ignition devices, all of which are frequently found to be less reliable after conversion."* The gas industry was aware of the issue and had already undertaken considerable work to rectify. Sir Henry commented: *"We are striving to get still further general improvements on those appliances which sometimes cause inconvenience."* (The Yorker 1970). Further investigation into the problems of ignition and controllability of natural gas was undertaken by the chairmen of the EMGB (Mr. K.L. Pearce) and WMGB (Mr. D. Beavis).

Thirdly, commenting on the 14 recommendations set out in the report, Sir Henry said Prof. Morton acknowledged some topics were already under consideration and modifications to existing regulations already in hand. *"Some of the recommendations are obviously matters for consideration and implementation by government departments and indeed some were the subject of safety clauses in the Gas Bill, which was lost as a result of the recent election,"* he said (The Yorker 1970).

Sir Henry added: *"This inquiry is independent proof that, subject to the ordinary human errors from which no organisation is exempt, the gas industry manufacturers and conversion contractors are doing a good job in bringing natural gas, a safe and acceptable fuel, to the homes and industries of Britain and we are determined to progress towards still higher standards of safety, workmanship, and service."* The gas industry was particularly pleased to see the recommendation to establish the Confederation for the Registration of Gas Installers (CORGI) (The Yorker 1970). In 1968, a 22-storey apartment block in Canning Town, London, called Ronan Point had been devastated by a gas explosion that led to five deaths. This disaster was attributed to unsafe gas fitting work in one of the apartments. It led to a drive to improve standards and the creation of CORGI to protect the public from any similar future incidents (Griffiths *et al* 1968).

A second report, known as the King Report or "Report of the Inquiry into Serious Gas Explosions" by Dr Philip King and two colleagues was prepared in 1977 (Lipscombe 1977a). These reports, along with the introduction of the Gas Safety Regulations in 1972 (Smith 1977), helped dispel some of the fears the public had around safety (Wilson 1976).

At the end of the conversion programme, Harold Lipscombe (1977) commented: *"Now the industry can say that there has been a truly major advance in safeguarding life as the non-toxic characteristics of natural gas has removed the hazard of poisoning."* This was reflected in the drop in unburnt gas fatalities (Carbon monoxide poisoning) which fell from 1,246 in 1963 and 745 in 1965 to 271 in 1970 (Smith 1977).

Local authorities were concerned with the cost of remedying unsafe flues. Maurice Redman commented in 1977: *"This was a task which became essential when the Gas Safety Regulations came into force in 1972. We were grateful to the local authorities for their responsible attitude in rectifying the problems, which have not always been so easy. Every local authority in Scotland faced up to its responsibility in this direction."* (Redman 1977).

The safety benefits to consumers were clear to the industry. Redman commented, *"In the course of visiting 850,000 homes and premises in Scotland, appliances have been checked and ventilation brought up to standard. We have found many potentially dangerous situations and putting these right has been an achievement in itself." (*Redman 1977*)*

Despite the insight the reports provided, they did not dispel the fears of all gas users. Although showing a decrease in serious explosions, the King report claimed not enough was done to alert the public to the potential hazards of gas. It also claimed safety was the responsibility of both the user and supplier. Everyone had to use their initiative on safety – both at work and at home – a claim backed by Scottish Gas Consumers Council in its annual report: *"Deliberate tampering or unskilled do it yourself endanger gas customers lives and property and other people as well."* Lipscombe (1977a) concurred: *"Yes, gas is a very safe fuel, at least as safe as any other— but, like all sources of heat and power, it must be treated with due respect."*

8. The communications and public relations story during conversion

8.1 National public relations

The advent of nationalisation centralised the public relations and communications effort with the Gas Council and within regional gas boards. For example, when NTGB was absorbed by the GLCC, the GLCC mascot, Mr Therm, was adopted by the industry.

At the time of conversion, it is estimated the gas industry had direct connection with 13 million customers. There was significant face-to-face connection through showrooms, where appliances could be demonstrated and purchased, and gas accounts settled. Home visits would be made by meter readers, gas fitters and the Home Service. This helped form goodwill and strong communications, contributing to the success of the conversion programme (Elliot 1980). The conversion itself, however, included little public consultation and was unwanted by most customers.

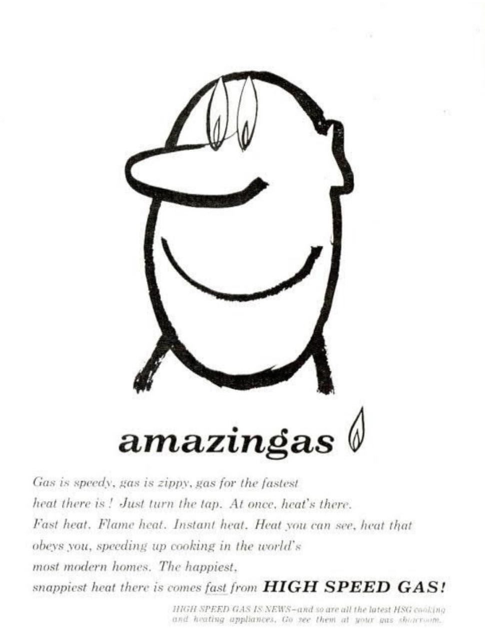


Figure 8.1 Mr Therm (left) and the Amazingas advert of the High Speed Gas campaign (right). Source - National Gas Archive.

As technology moved away from coal and society adopted more oil-based reforming technology in the 1960’s, Mr Therm was retired. A successful marketing campaign for ‘High Speed Gas’ and an uptake in domestic gas central heating saw increased demand (Elliot 1980).

A major public relations campaign was needed to garner support (Elliot 1980) and ensure clear and informative messaging. Domestic, commercial, and industrial customers had to be informed on the reasoning and process for conversion. Transparency was top priority, no false promises and showing clear benefit to the nation, without exaggeration (McCawley 1977).

Following the conversion trial at Canvey Island, William Camp, who headed public relations at the Gas Council, set up a working party to ensure cooperation between the boards. This included officers from four regional gas boards and members of the Gas Council Press and Information Office.

Camp’s deputy and Chief Press Officer, Charles Elliot, pushed to produce the Conversion Public Relations Handbook. The handbook was developed by public relations expert, Alan Sharpe, who had worked with the Conversion Executive and drafted much of the campaign’s material (Elliot 1980). The handbook gave a balanced view of the difficulties encountered during the programme as well as its successes.

The handbook recommended public information should be kept on general terms as it may both unsettle and confuse the public rather than reassure them. It was thought local communications may better serve this purpose as the conversion programme advanced (Elliot 1980).

The Gas Council invested heavily in publications on conversion, which were published at regular intervals throughout. They started before conversion, focusing on the journey of gas made from coal to the switch to gas made from refinery gases and LNG importation.

Initial national publicity was linked closely with the benefits of natural gas, however, some of this was regarded as being overly optimistic, especially in the early years of North Sea natural gas. Headlines like ‘North Sea Gas Bonanza’ led to much hype and overlooked the scale of the engineering challenge and the differences in the nature of the new gas. This inspired the Gas Council to produce more focused publicity material on how gas was to be obtained and on more practical aspects of conversion as well as its implications (Elliot 1980). Titles included:

- A booklet **Natural Gas for Britain**, published by the Gas Council in April 1965. This pre-conversion booklet described the Canvey Island Methane Terminal, the National Methane Pipeline and how the imported gas was to be used.
- A leaflet **Natural High-Speed Gas** outlined the arrival of natural gas, how it differed from town gas and general information about the conversion process and impact on appliances. It was published by the Gas Council in 1966.
- A booklet **Gas in Your Home** was published by the Gas Council in 1966. The 3rd edition of this 20-page booklet had been completely rewritten since the 2nd edition of 1961 to explain the implications of conversion to natural gas. Previous editions had only been focused on town gas.
- A booklet **Changing to Natural Gas** was published by the Gas Council in 1967. It explained why the country was changing to natural gas, how natural gas could be used and how conversion is carried out.
- A booklet **Natural Gas from the North Sea**, published by the Gas Council in 1967. It described the formation and nature of natural gas and additional information about the impending conversion.
- A booklet **Conversion to North Sea Gas, the perfect fuel for industry**, published by the Gas Council in 1969. It outlined the benefits of industry switching to natural gas.
- A booklet **Gas Council, Whys and Wherefores of Conversion. Natural Gas and its Implications**, published by the Gas Council in 1969. This explained the benefits of switching to natural gas and any associated implications.
- A booklet **Britain's Natural Gas**, published by the Gas Council in 1971. It explained how Britain was going to maximise the benefits of North Sea gas for the country.
- A booklet **Conversion to Natural Gas, a Guide for Industry**, published by the Gas Council in 1971, It outlined the benefits of industry switching to natural gas and a guide for industrial users.
- A booklet **Natural Gas and What it Means to You**, published by the Gas Council in 1971. It explained in clear and simple language the impacts of using natural gas on appliances and drew attention to cheaper tariffs being introduced at the time.
- **Investment in Natural Gas** gave an outline of the industry's plans and prospects based on natural gas (McCawley 1977).

The front cover of some of these booklets is shown in Figure 8.2.

Figure 8.2. Examples of public Information documents about gas. Source - National Gas Archive.

Similar material was provided for use in newspapers, magazines, trade press, radio and television. The gas industry had built strong links with the media in the 1960s with the 'High Speed Gas' campaign and the same front-foot approach was needed to inform the public during conversion. They developed particularly strong links with labour and industrial correspondents and those specialising in women's and domestic affairs (Elliot 1980).

The Gas Council, regional gas boards and later the British Gas Corporation produced films such as the 'Age of Conversion' produced by NEGB and 'Britain's Natural Gas – Past Present and Future', produced by the British Gas Corporation.

The team kept a constant feed of new information through press conferences, press releases and informal meetings on natural gas and the conversion process (McCawley 1977, Elliot 1980) to maintain interest. It also publicised the cost reduction switching would deliver, which helped drive public support (Elliot 1980). While scathing at times, the press did succeed in garnering support among female readers. This was more impactful across the wider population than some of the more technical articles (Elliot 1980). Public exhibitions were also held to inform customers about natural gas. These included displays such as a Meccano model of an oil rig (Figure 8.3)

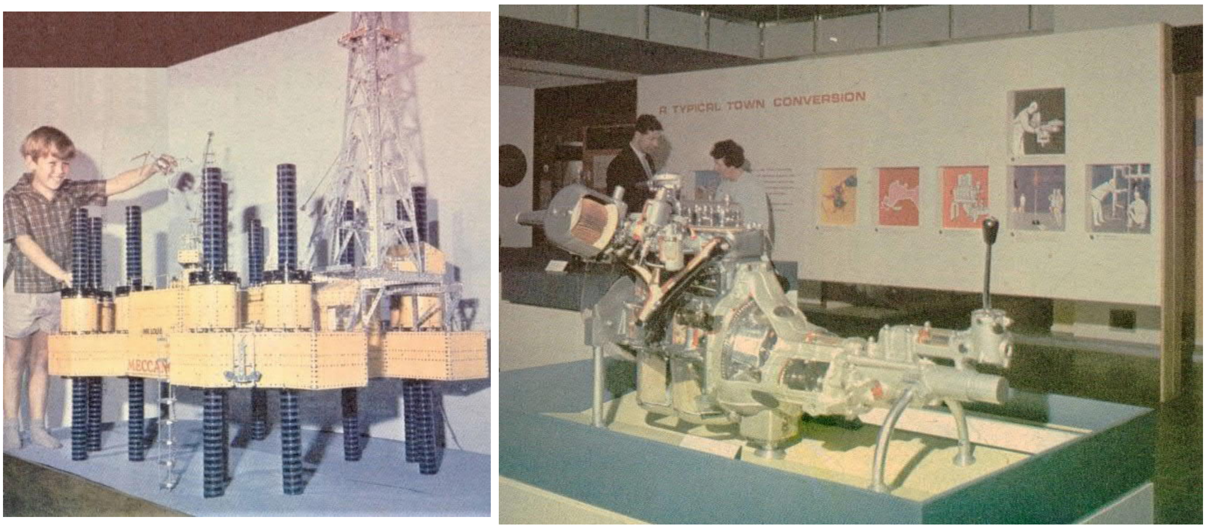


Figure 8.3. A Meccano model of a rig used for gas exploration (Left) and display at Solihull offices of the WMGB in 1967. Source - National Gas Archive.

8.2 Regional public relations

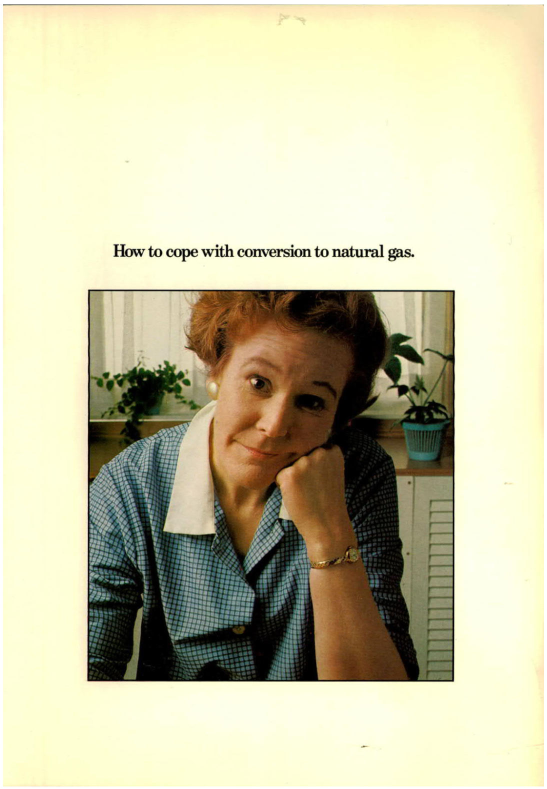
Conversion was not initially welcomed by some consumers, who were happy with their existing supply, a situation exacerbated by negative media reports. Concerns were also raised by decision makers.

Regional boards trialled a publicity campaign for natural gas through different forms of media ahead of the conversion. Initially, they held information sharing sessions between conversion managers and PR teams, MPs, councillors and council officers, social services, hospitals, schools and police officials to establish the integrity of the conversion and the support required (McCawley 1977).

They then used letters, radio interviews and video demonstrations to inform the public, highlighting the long-term benefits outweighing the short-lived inconvenience (McCawley 1977, Elliot 1980). The NEGAS Display Design department developed a logo featuring a trident rising from the North Sea, with a gas flame burning from each prong of the trident. This was used on correspondence and publicity material, as well as the conversion fleet and showroom displays (Yorker August 1967, McCawley 1977).

Regional gas boards also produced regional publications, some of which were also printed in minority languages (Elliot 1980):

- A booklet **Conversion to Natural Gas**, published by NEGAS in 1971.
- A booklet **How to cope with conversion to natural gas,** published by EMGAS in 1973.



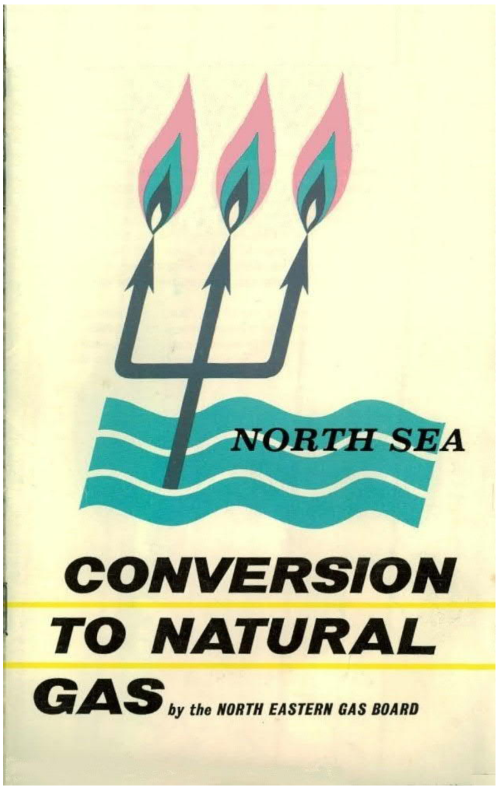


Figure 8.4. Examples of regional public relations sent out to customers. Source - National Gas Archive.

Regional gas boards also offered demonstrations of how cooking with natural gas compared to town gas, at their local showrooms, some of which had dedicated theatres for such events (Figure 8.5).

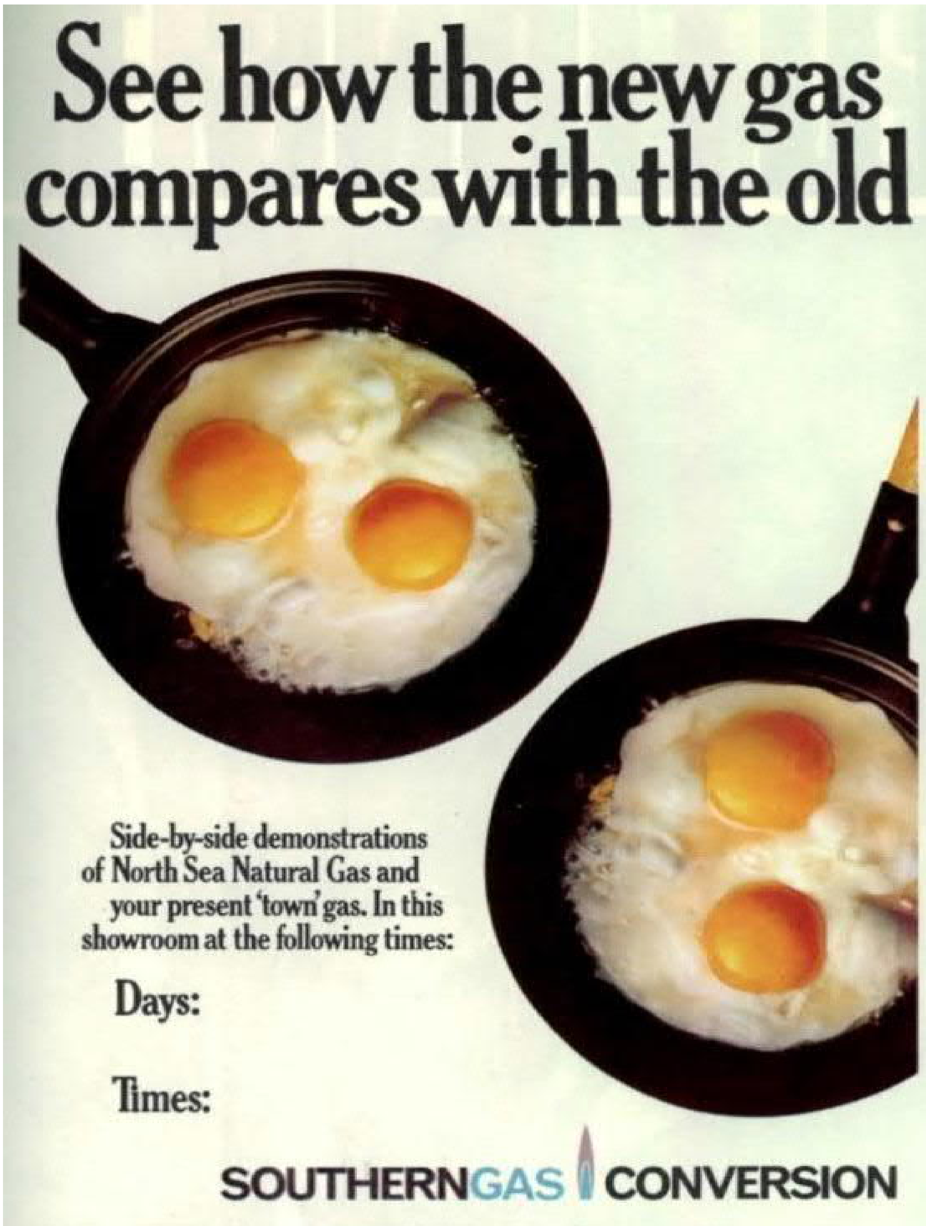


Figure 8.5. Advertising for a cooking demonstration undertaken by Southern Gas to showcase cooking using natural gas. Source - National Gas Archive.

The West Midlands Region and WMGB before them estimated they had sent 8 million letters, received 4.5 million, hosted 160 public meetings and given 1,147 talks on the conversion process. Interest of the regional paper the *Birmingham Mail* was considerable, with reporter Maurice Rotheroe commenting after the first conversions in Coleshill: *"I was variously told that North Sea gas flames were quieter, noisier, bluer, paler, larger, smaller, thinner and fatter, Since I consumed what was probably the first steak cooked by Natural Gas in the West Midlands, I can vouch that the taste is the same as before."* (Boost 1968)

There were mixed views from the public about the Coleshill conversion, ranging from one interviewee saying it was *"the worst piece of organisation he had ever seen", while another who had his gas supply restored later in the day saying "I think the gas board are doing well, this is a big job to organise."* Much of the concern before conversion was about the noise and appearance of the flame and whether it would cook faster or slower than before (Boost 1968).

Local press was useful in conveying messages to the public in the WMGB region. One of the main issues it faced was lack of access, which would result in premises being cut-off. This was a significant issue in Leamington Spa, where due to the timing near the September Bank Holiday, access to properties was particularly bad. This was relayed back through the press before the sixth sector in Leamington Spa, which then achieved access to all properties. At around the same time, good success had been achieved in conversion in the Hinkley area, where only three customers had to be cut off, which local *Leicester Mercury* described as having been carried out "smoothly with superb efficiency" (Boost 1968a).

Public Relations in the WMGB region was a constant battle and, in 1970, Bill Kidman admitted: *"There is a hard core of cases which go badly astray, possibly leaving the customer without the use of an appliance. The percentage in relation to total conversions is very small – remember now we are converting 2,000 customers and 5,000 appliances every week. But these are the one that make the headlines and distort the true picture."* This showed what the impact of just a few troubling conversions or mistakes could have on the image of the gas board (Kidman 1970).

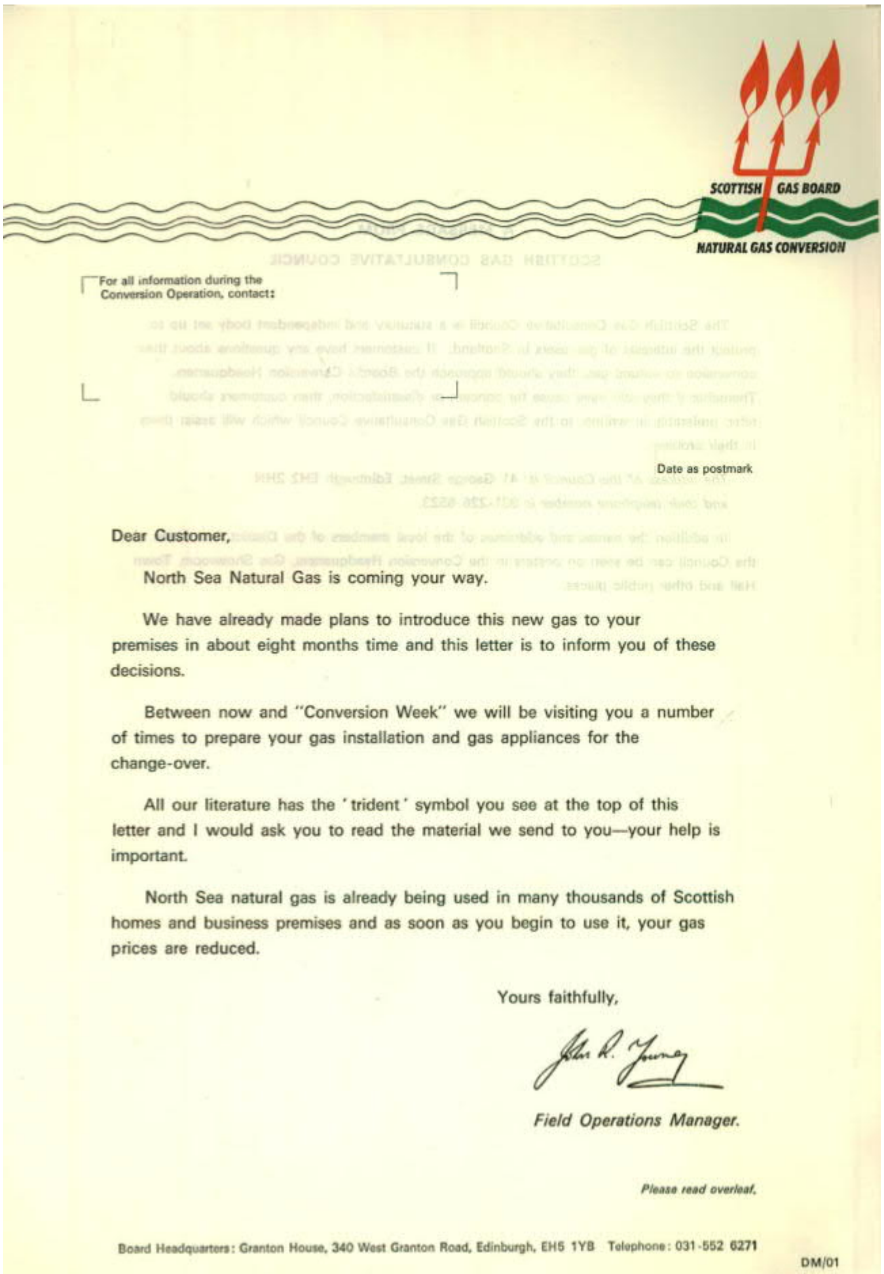
Figure 8.6. A Photograph appearing in local press showing a fitter preparing to convert a gas fire, Coleshill 1968. Source - National Gas Archive.

Public relations in the West Midlands reflected after the programme had finished: *"As far as some customers were concerned, we did our conversion at the wrong time of the year for them – whatever the time of year we chose! If it was winter, they objected to appliances being disturbed because of the cold weather and in the summer, conversion represented an inconvenience because of the holiday period. It was very important then that we carried the approval of the general public."* (Boost 1976)

An insight into the thinking of the SEGB was provided by its Publicity Manager S. R. Hill, who said the board viewed the customer as a female, lively, quick-witted and intelligent person who knows value for money when she sees it. And she wants to know all about conversion to Natural High-Speed Gas. This view of women as the key decision maker in households was a firmly held belief in the gas industry, reflected over many years. The publicity campaign was therefore designed to tell women all about conversion from town gas to natural gas (Hill 1968).

8.3 Communication timeline

Direct communication to customers started eight months before conversion with a letter entitled "Natural Gas is Coming Your Way". It explained the need for visits to the property and also highlighted the trident branding so the customer would be aware of any such subsequent communications. It also let them know natural gas was already being used by ScGB customers and their gas prices would be reduced (McCawley 1977). An example of this ScGB letter is seen in Figure 8.7.



SCOTTISH GAS BOARD
NATURAL GAS CONVERSION

For all information during the Conversion Operation, contact:

Date as postmark

Dear Customer,

North Sea Natural Gas is coming your way.

We have already made plans to introduce this new gas to your premises in about eight months time and this letter is to inform you of these decisions.

Between now and "Conversion Week" we will be visiting you a number of times to prepare your gas installation and gas appliances for the change-over.

All our literature has the 'trident' symbol you see at the top of this letter and I would ask you to read the material we send to you—your help is important.

North Sea natural gas is already being used in many thousands of Scottish homes and business premises and as soon as you begin to use it, your gas prices are reduced.

Yours faithfully,

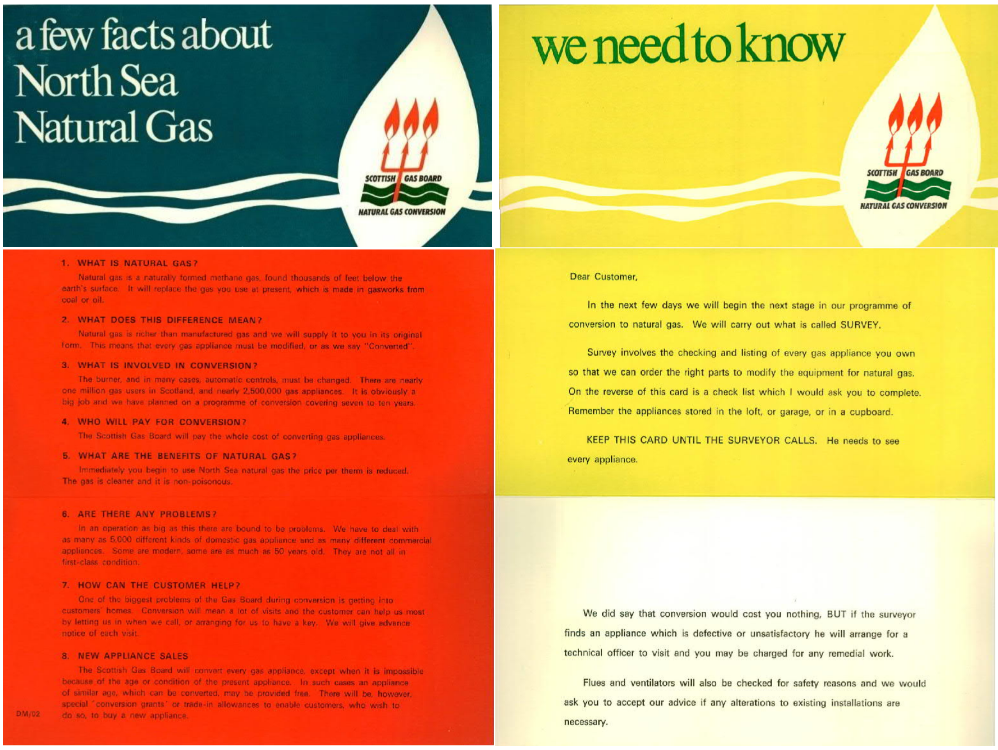
Field Operations Manager.

Please read overleaf.

Board Headquarters: Granton House, 340 West Granton Road, Edinburgh, EH5 1YB Telephone: 031-552 6271

DM/01

Figure 8.7. The first letter sent to customers informing them of the conversion programme. Source - National Gas Archive.



a few facts about North Sea Natural Gas

SCOTTISH GAS BOARD
NATURAL GAS CONVERSION

1. WHAT IS NATURAL GAS?

Natural gas is a naturally formed methane gas, found thousands of feet below the earth's surface. It will replace the gas you use at present, which is made in gasworks from coal or oil.

2. WHAT DOES THIS DIFFERENCE MEAN?

Natural gas is richer than manufactured gas and we will supply it to you in its original form. This means that every gas appliance must be modified, or as we say "Converted".

3. WHAT IS INVOLVED IN CONVERSION?

The burner, and in many cases, automatic controls, must be changed. There are nearly one million gas users in Scotland, and nearly 2,500,000 gas appliances. It is obviously a big job and we have planned on a programme of conversion covering seven to ten years.

4. WHO WILL PAY FOR CONVERSION?

The Scottish Gas Board will pay the whole cost of converting gas appliances.

5. WHAT ARE THE BENEFITS OF NATURAL GAS?

Immediately you begin to use North Sea natural gas the price per therm is reduced. The gas is cleaner and it is non-poisonous.

6. ARE THERE ANY PROBLEMS?

In an operation as big as this there are bound to be problems. We have to deal with as many as 5,000 different kinds of domestic gas appliance and as many different commercial appliances. Some are modern, some are as much as 50 years old. They are not all in first-class condition.

7. HOW CAN THE CUSTOMER HELP?

One of the biggest problems of the Gas Board during conversion is getting into customers' homes. Conversion will mean a lot of visits and the customer can help us most by letting us in when we call, or arranging for us to have a key. We will give advance notice of each visit.

8. NEW APPLIANCE SALES

The Scottish Gas Board will convert every gas appliance, except when it is impossible because of the age or condition of the present appliance. In such cases an appliance of similar age, which can be converted, may be provided free. There will be, however, special 'conversion grants' or trade-in allowances to enable customers, who wish to do so, to buy a new appliance.

DM/02

we need to know

SCOTTISH GAS BOARD
NATURAL GAS CONVERSION

Dear Customer,

In the next few days we will begin the next stage in our programme of conversion to natural gas. We will carry out what is called SURVEY.

Survey involves the checking and listing of every gas appliance you own so that we can order the right parts to modify the equipment for natural gas. On the reverse of this card is a check list which I would ask you to complete. Remember the appliances stored in the loft, or garage, or in a cupboard.

KEEP THIS CARD UNTIL THE SURVEYOR CALLS. He needs to see every appliance.

We did say that conversion would cost you nothing, BUT if the surveyor finds an appliance which is defective or unsatisfactory he will arrange for a technical officer to visit and you may be charged for any remedial work.

Flues and ventilators will also be checked for safety reasons and we would ask you to accept our advice if any alterations to existing installations are necessary.

Figure 8.8. Literature sent out by the Scottish Gas Board. Source - National Gas Archive.

This letter, which would be signed by the Field Operations Manager, was accompanied by an explanatory leaflet giving 'a few facts about North Sea Natural Gas'. An example of this is shown in Figure 8.8 (left). It explained what natural gas was and what its benefits were, why there was a difference with town gas and why conversion was required and who would pay for it. It also explained what problems may be encountered, how the customer could help and how new appliances could be bought with the aid of a conversion grant.

One week before survey, another leaflet entitled 'We need to know' (Figure 8.8 right) was issued, which explained the gas board required the listing of each of the customer's gas appliances. This would help identify appliances and help the engineer order the correct conversion kits. There was a checklist included for the customer to complete and hand over to the surveyor when they visited. Surveys were conducted around six months before conversion and were preceded by the circulation of leaflets highlighting the implications of conversion.

At the time of the survey, another leaflet was sent to the customer to boost their awareness of the implications of conversion named 'The 5 stages of conversion' (Figure 8.9). It discussed the preliminary work, survey, new appliance sales, conversion and call back and informed the customer that, when they began to use natural gas, they would immediately qualify for a reduction in gas price. It clearly highlighted any conversion programme personnel who visited would carry an identification card, which customers were advised to check.

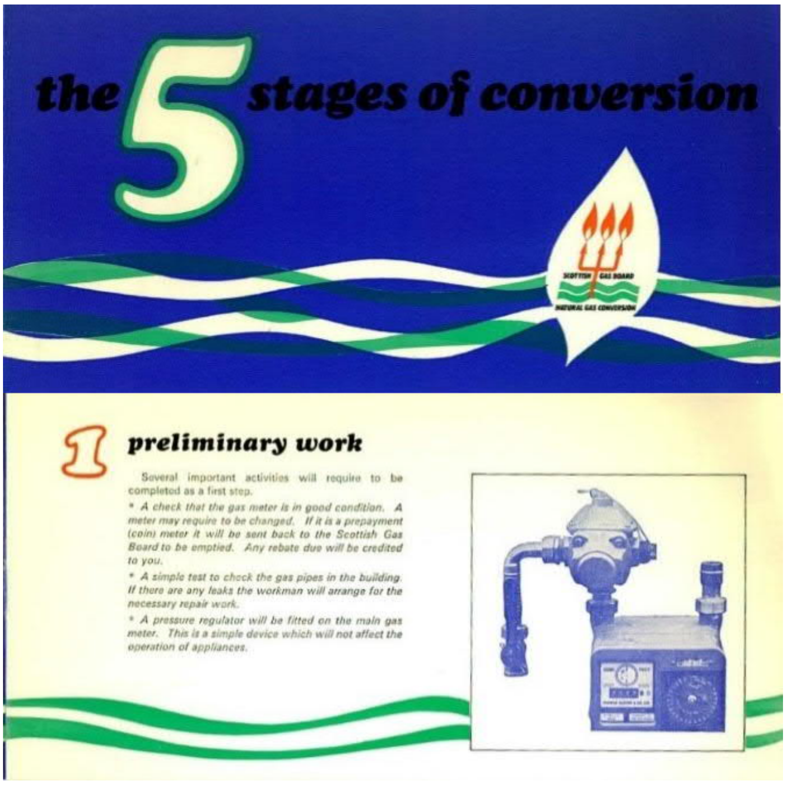
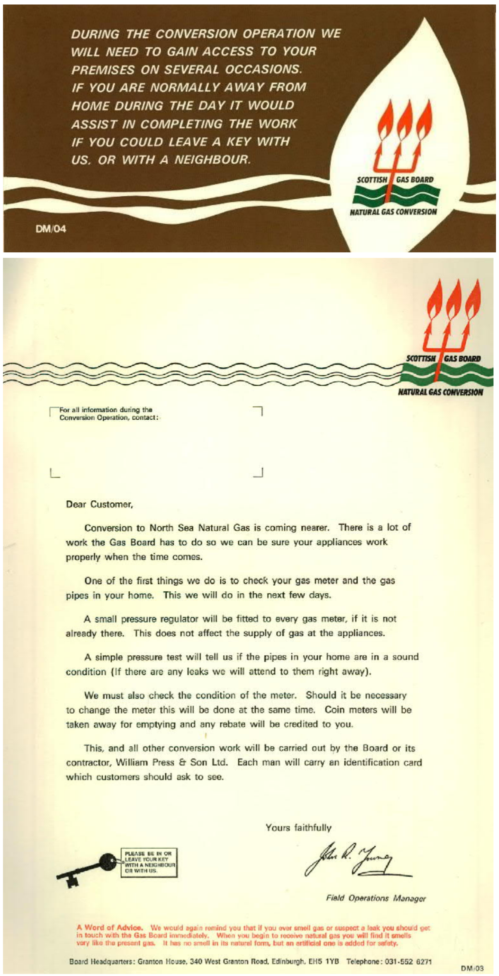


Figure 8.9. The leaflet 'the 5 stages of conversion' and an example of a page of its contents. Source - National Gas Archive.

At between three and five months before Conversion Day, the customer would receive another letter from the Field Operations Manager (Figure 8.10) to inform them conversion is approaching and describing some of the work required to ensure appliances worked properly on the day. It included instructions that staff would check the gas meter and pipes and fit a small pressure regulator to every meter. It also reiterated all work would be carried out by the Board or its contractor (in this case William Press & Son. Ltd.) and reminded customers to check conversion staff identification.


DURING THE CONVERSION OPERATION WE WILL NEED TO GAIN ACCESS TO YOUR PREMISES ON SEVERAL OCCASIONS. IF YOU ARE NORMALLY AWAY FROM HOME DURING THE DAY IT WOULD ASSIST IN COMPLETING THE WORK IF YOU COULD LEAVE A KEY WITH US, OR WITH A NEIGHBOUR.

SCOTTISH GAS BOARD
NATURAL GAS CONVERSION

DM/04

SCOTTISH GAS BOARD
NATURAL GAS CONVERSION

For all information during the Conversion Operation, contact:

Dear Customer,

Conversion to North Sea Natural Gas is coming nearer. There is a lot of work the Gas Board has to do so we can be sure your appliances work properly when the time comes.

One of the first things we do is to check your gas meter and the gas pipes in your home. This we will do in the next few days.

A small pressure regulator will be fitted to every gas meter, if it is not already there. This does not affect the supply of gas at the appliances.

A simple pressure test will tell us if the pipes in your home are in a sound condition (If there are any leaks we will attend to them right away).

We must also check the condition of the meter. Should it be necessary to change the meter this will be done at the same time. Coin meters will be taken away for emptying and any rebate will be credited to you.

This, and all other conversion work will be carried out by the Board or its contractor, William Press & Son Ltd. Each man will carry an identification card which customers should ask to see.

Yours faithfully

PLEASE BE IN OR LEAVE YOUR KEY WITH A NEIGHBOUR OR WITH US.

Field Operations Manager

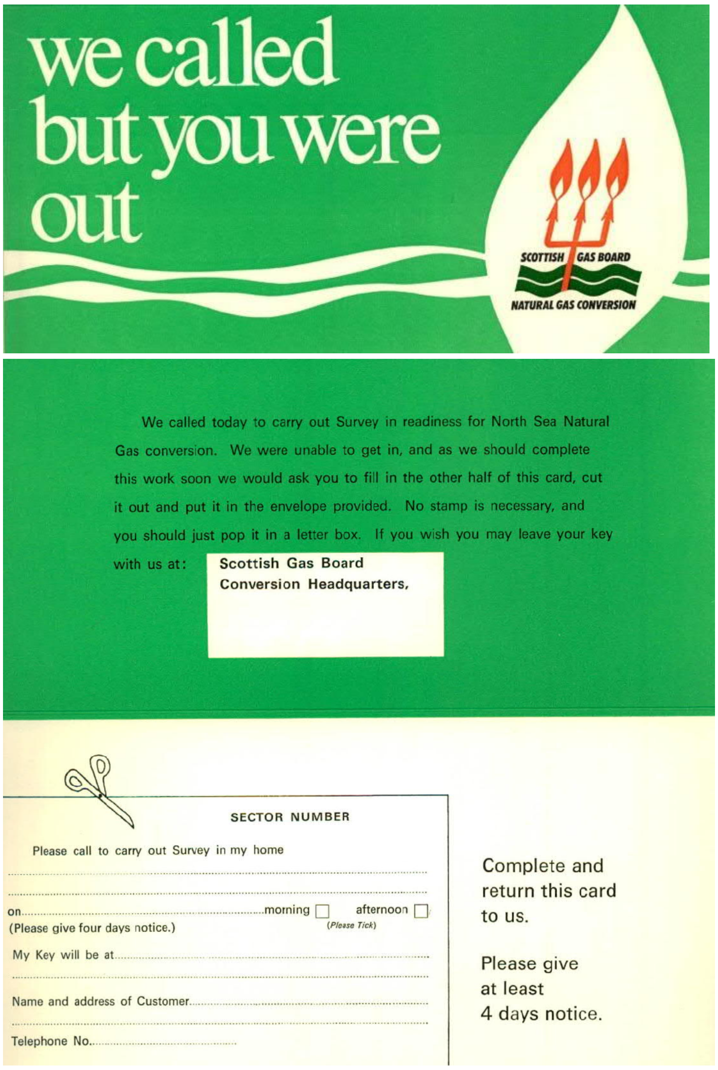
A Word of Advice. We would again remind you that if you ever smell gas or suspect a leak you should get in touch with the Gas Board immediately. When you begin to receive natural gas you will find it smells very like the present gas. It has no smell in its natural form, but an artificial one is added for safety.

Board Headquarters: Granton House, 340 West Granton Road, Edinburgh, EH5 1YB Telephone: 031-552 6271

DM/03

Figure 8.10. The letter requiring access and changes to be made to the gas installation in the premises. Source - National Gas Archive.

Gaining access to properties was one of the biggest issues for the conversion programme, referred to as CGI or ‘can’t get in’. Gas boards devised colourful cards and letters entitled ‘We called but you were out’, shown in Figure 8.11. On its reverse was a printed card for customers to send off in an enclosed envelope stating when access can be obtained or where a key was to be left (McCawley 1977).



we called but you were out

SCOTTISH GAS BOARD
NATURAL GAS CONVERSION

We called today to carry out Survey in readiness for North Sea Natural Gas conversion. We were unable to get in, and as we should complete this work soon we would ask you to fill in the other half of this card, cut it out and put it in the envelope provided. No stamp is necessary, and you should just pop it in a letter box. If you wish you may leave your key with us at: Scottish Gas Board Conversion Headquarters,

SECTOR NUMBER

Please call to carry out Survey in my home ....

on.................................... morning ☐ afternoon ☐ (Please Tick)

(Please give four days notice.)

My Key will be at..

Name and address of Customer..

Telephone No..

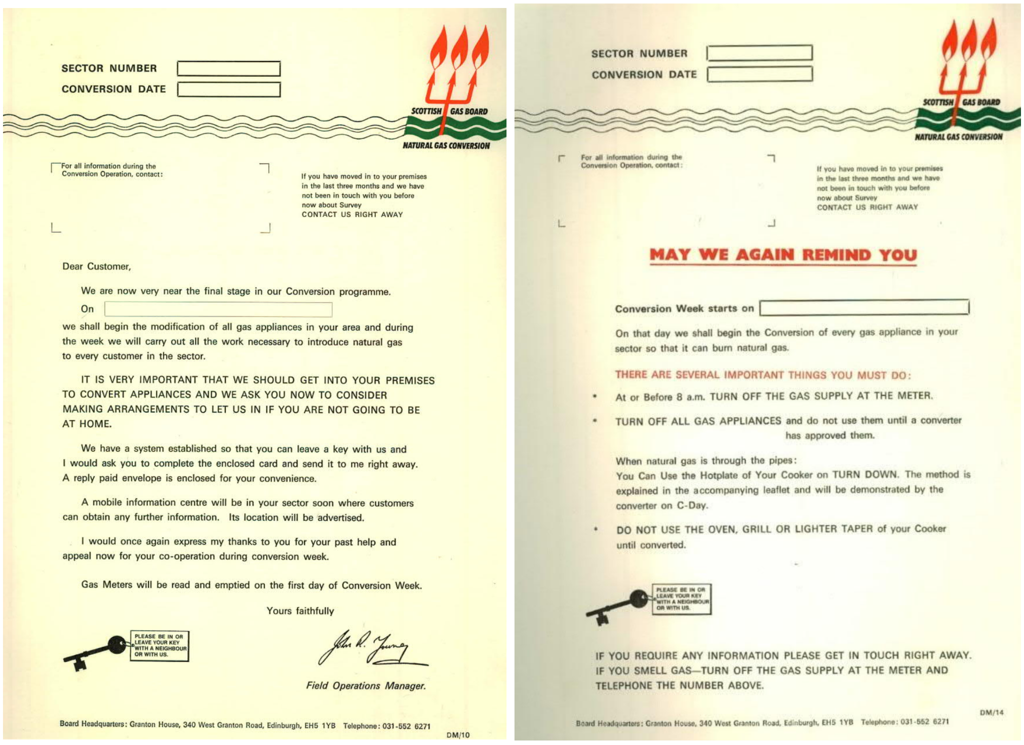
Complete and return this card to us.

Please give at least 4 days notice.

Figure 8.11. The card left if no one was present at home and the associated form to complete. Source - National Gas Archive.

If there was any pre-conversion work required at the premises, where appliances required repair or maintenance, the Board sent another letter informing customers it needed doing and access to the property would be required.

John Cairns, who was the supervisor of the two Mobile Information Centres (MIC) operated by ScGB, was part of the conversion team from the start. The MICs visit sectors the week before they were due for conversion. He said of his role: *"It has been a very satisfying job which I have enjoyed thoroughly. For the last seven years I have been meeting the public and answering their questions and generally putting their minds at ease, especially the older folk who find it a bit difficult to understand conversion at times."* (Prentice 1977)


SECTOR NUMBER
CONVERSION DATE

SCOTTISH GAS BOARD
NATURAL GAS CONVERSION

For all information during the Conversion Operation, contact:

If you have moved in to your premises in the last three months and we have not been in touch with you before now about Survey
CONTACT US RIGHT AWAY

Dear Customer,

We are now very near the final stage in our Conversion programme.

On

we shall begin the modification of all gas appliances in your area and during the week we will carry out all the work necessary to introduce natural gas to every customer in the sector.

IT IS VERY IMPORTANT THAT WE SHOULD GET INTO YOUR PREMISES TO CONVERT APPLIANCES AND WE ASK YOU NOW TO CONSIDER MAKING ARRANGEMENTS TO LET US IN IF YOU ARE NOT GOING TO BE AT HOME.

We have a system established so that you can leave a key with us and I would ask you to complete the enclosed card and send it to me right away. A reply paid envelope is enclosed for your convenience.

A mobile information centre will be in your sector soon where customers can obtain any further information. Its location will be advertised.

I would once again express my thanks to you for your past help and appeal now for your co-operation during conversion week.

Gas Meters will be read and emptied on the first day of Conversion Week.

Yours faithfully

Field Operations Manager.

PLEASE BE IN OR LEAVE YOUR KEY WITH A NEIGHBOUR OR WITH US.

Board Headquarters: Granton House, 340 West Granton Road, Edinburgh, EH5 1YB Telephone: 031-552 6271

DM/10

SECTOR NUMBER
CONVERSION DATE

SCOTTISH GAS BOARD
NATURAL GAS CONVERSION

For all information during the Conversion Operation, contact:

If you have moved in to your premises in the last three months and we have not been in touch with you before now about Survey
CONTACT US RIGHT AWAY

MAY WE AGAIN REMIND YOU

Conversion Week starts on

On that day we shall begin the Conversion of every gas appliance in your sector so that it can burn natural gas.

THERE ARE SEVERAL IMPORTANT THINGS YOU MUST DO:

- At or Before 8 a.m. TURN OFF THE GAS SUPPLY AT THE METER.
- TURN OFF ALL GAS APPLIANCES and do not use them until a converter has approved them.

When natural gas is through the pipes:
You Can Use the Hotplate of Your Cooker on TURN DOWN. The method is explained in the accompanying leaflet and will be demonstrated by the converter on C-Day.

- DO NOT USE THE OVEN, GRILL OR LIGHTER TAPER of your Cooker until converted.

PLEASE BE IN OR LEAVE YOUR KEY WITH A NEIGHBOUR OR WITH US.

IF YOU REQUIRE ANY INFORMATION PLEASE GET IN TOUCH RIGHT AWAY.
IF YOU SMELL GAS—TURN OFF THE GAS SUPPLY AT THE METER AND TELEPHONE THE NUMBER ABOVE.

DM/14

Board Headquarters: Granton House, 340 West Granton Road, Edinburgh, EH5 1YB Telephone: 031-552 6271

Figure 8.12. Additional letters sent to customers. Source - National Gas Archive.

Some 18 days before conversion week in the sector, customers would receive a letter from the Field Operations Manager (Figure 8.12 left) informing them of the date their appliances would be converted. The letter stressed the importance of entry to the property and told customers it was time "now to consider making arrangements to let us in if you are not going to be at home." It explains there was a system established "so that you can leave a key with us". It included a card requiring completion and a pre-paid envelope. Customers were also informed when an MIC would be visiting the sector.

One week before Conversion Day, every customer received a reminder called 'May we again remind you' (Figure 8.12 right). Accompanying this was a colourful booklet 'How conversion is carried out' explaining the process using cartoons (Figure 8.13). The six light-hearted cartoons with their brief captions would take the customer through the conversion process, with the last showing the all-important key to the house to reinforce the message converters must be able to get in.

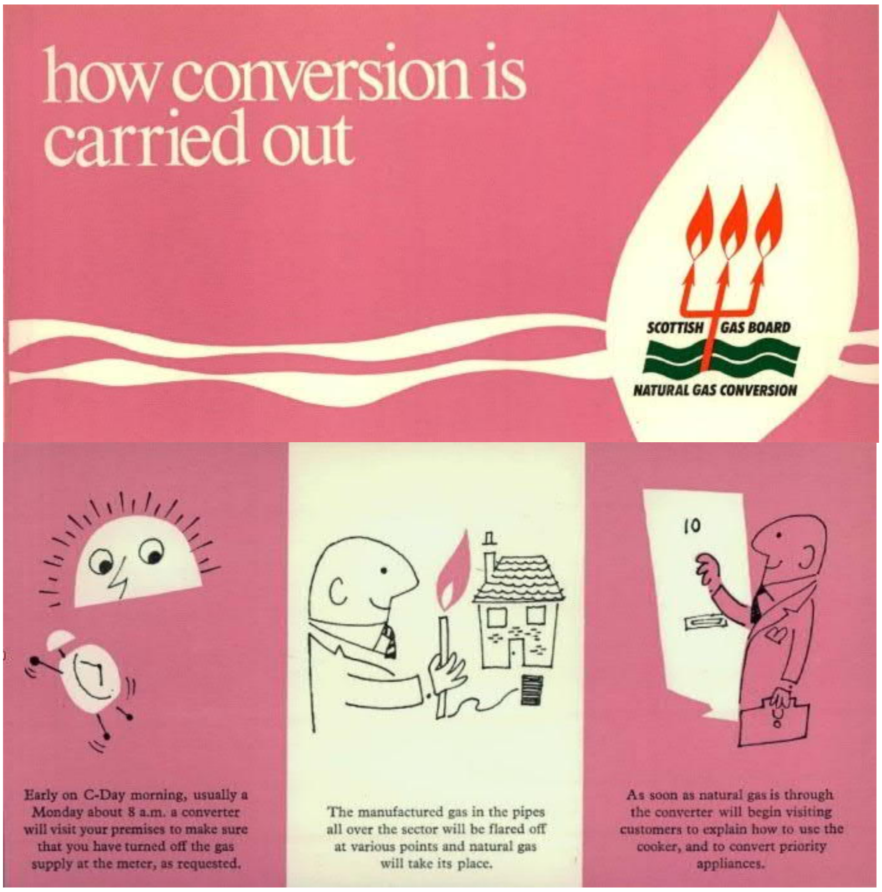


Figure 8.13. A booklet sent to customers explaining how conversion was carried out. Source - National Gas Archive.

Regional gas boards were realistic in their expectation of some inevitable complaints or concerns and provided other material including the card entitled 'In case of difficulty' (Figure 8.14 left), ready to deal with the inevitable complaints, concerns, or queries. They also advertised they were operating a free service to every customer. Those requiring support were asked to complete the reverse side of the card post it right away, with the gas board attending to all complaints as soon as possible. The card listed the gas appliances requiring attention and the customer was asked to tick appropriate boxes and to indicate when they would be at home. This card also thanked the customer for their cooperation during conversion.

In case of any unavoidable delay, another card was provided to the customer entitled 'we apologise' (Figure 8.14), advising the Board would have to return at a later date to undertake the works.

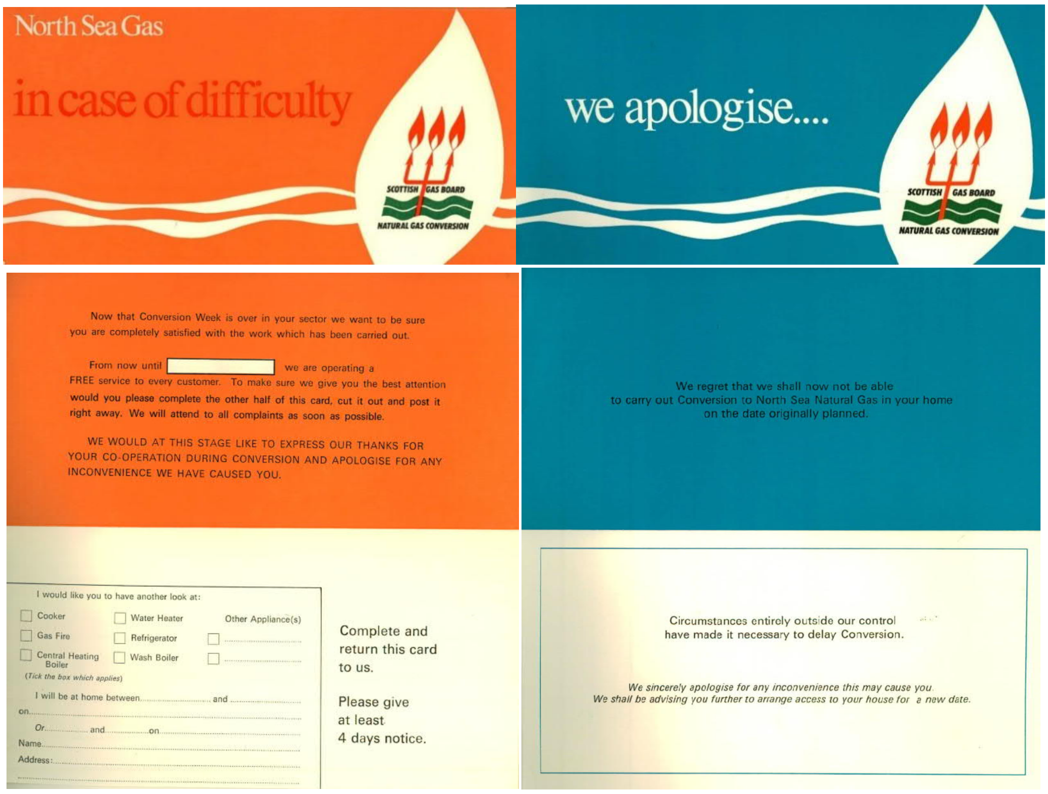
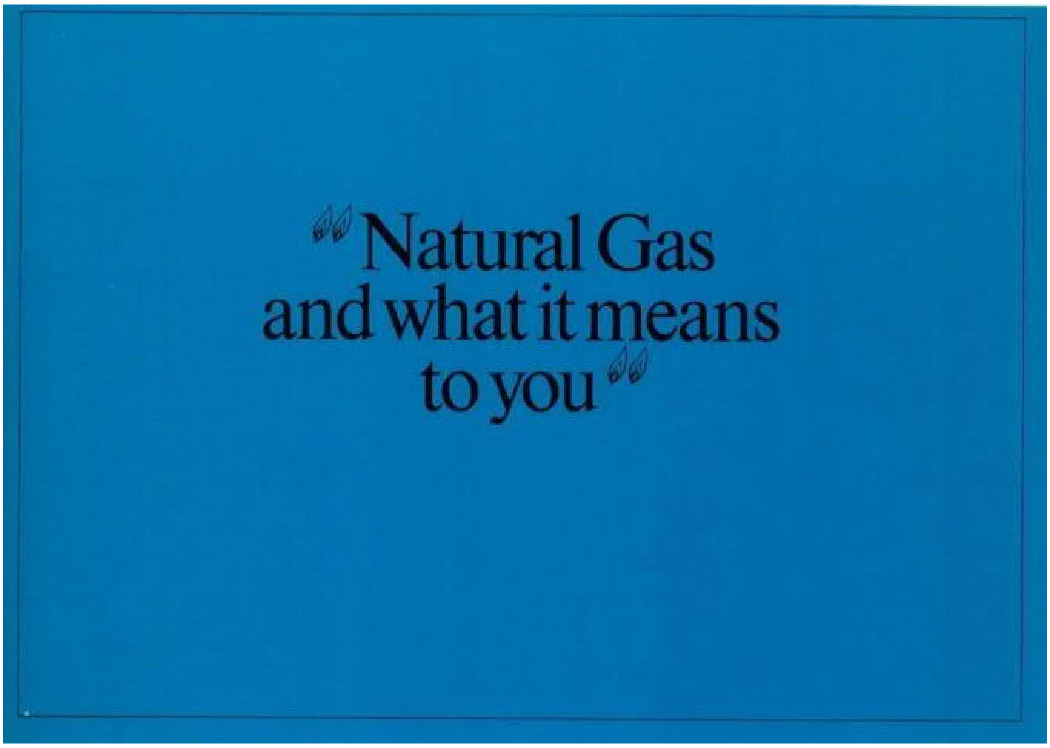
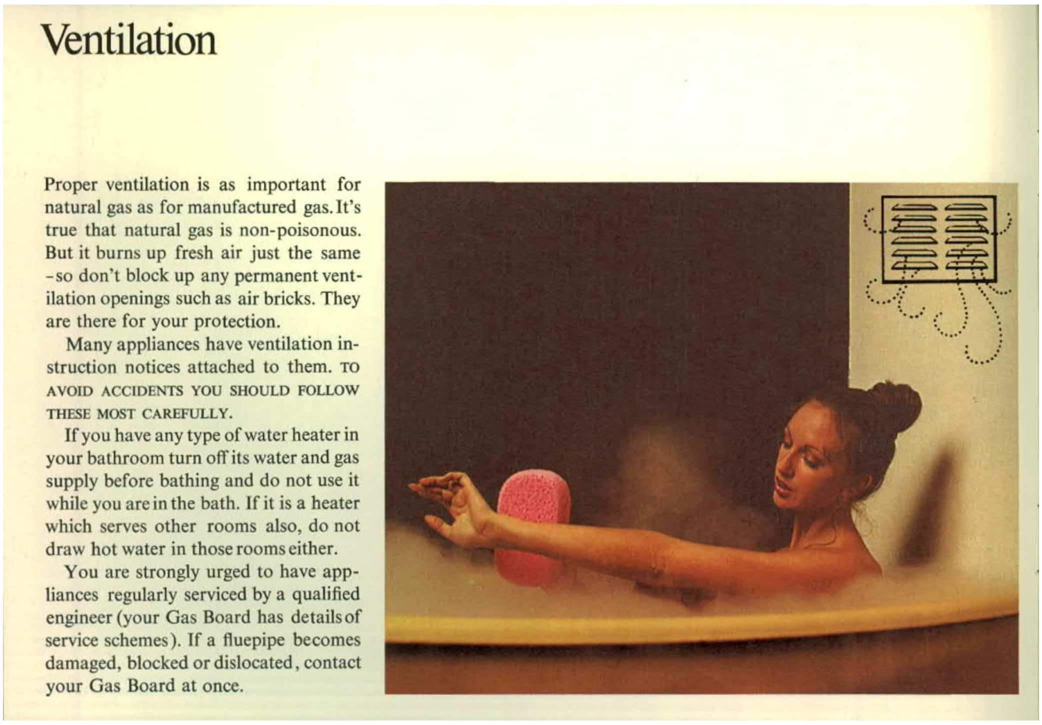


Figure 8.14. The cards put through the door after conversion (left) or if the conversion had been delayed for unforeseen circumstances (right). Source - National Gas Archive.



Customers were also left with a booklet entitled ‘Natural Gas and what it means to you’. It included sections such as Getting used to natural gas, Ventilation, Lighting the Gas, Cookers, Refrigerators and Water heaters, Gas Fires, Central heating, Post Conversion service, Gas bills and Are you on the right tariff? (Figure 8.14). The information on ventilation was important. Natural gas was advertised as not toxic, so there was a risk people would block ventilation and carbon dioxide could instead build up in unventilated rooms.



Ventilation

Proper ventilation is as important for natural gas as for manufactured gas. It's true that natural gas is non-poisonous. But it burns up fresh air just the same –so don't block up any permanent ventilation openings such as air bricks. They are there for your protection.

Many appliances have ventilation instruction notices attached to them. TO AVOID ACCIDENTS YOU SHOULD FOLLOW THESE MOST CAREFULLY.

If you have any type of water heater in your bathroom turn off its water and gas supply before bathing and do not use it while you are in the bath. If it is a heater which serves other rooms also, do not draw hot water in those rooms either.

You are strongly urged to have appliances regularly serviced by a qualified engineer (your Gas Board has details of service schemes). If a fluepipe becomes damaged, blocked or dislocated, contact your Gas Board at once.

Figure 8.15 The booklet "Natural Gas and what is means to you", given out by the Gas Boards After Conversion and example page on Ventilation. Source - National Gas Archive.

There was some regional variation in how the gas boards operated. The SEGB first sent the customer a simple, straightforward guide "published in the interests of domestic users" in an envelope marked "IMPORTANT" and carrying the specially designed SEGAS symbol. This was sent out six months before the conversion process started and was the first contact made with the customer on the subject. Its contents included: 1) This is what happens before you are converted, 2) This is what happens on Conversion Day, 3) What to do if you cannot be at home on Conversion Day and 4) General information (Hill 1968).

SEGB sent out a Booklet two weeks before conversion (Figure8.16). This provided a recap on the general information and more specific details of what would happen. It provided a telephone number so any queries could be raised and the customer also had the option of visiting the nearest gas showroom or Mobile Service Centre (Hill 1968).

Figure 8.16. SEGB logos used on literature and booklet sent out to customers. Source - National Gas Archive.

The significant amount of literature made available both at the national and regional level made clear managements' determination to achieve the public relations aim of telling customers as much as possible as early as appropriate. The eye-catching design of the public relations material with bright colours and strong branding must have succeeded in their aim of attracting attention and being read. Whatever criticism there may have been of the conversion programme, there was no serious charge against the regional gas boards of failing to inform customers (McCawley 1977).

8.4 Assessing customer attitudes

The gas industry carefully monitored customer attitudes and the Gas Council commissioned confidential reports into them, produced by Market Information Services Ltd of London. These reports were produced annually and based on customer surveys with the purpose of informing the Gas Council if there were significant changes in customer attitudes (Market Information Services Ltd 1968, Market Information Services Ltd 1968a, Market Information Services Ltd 1971).

Regional gas boards also commissioned surveys to assess customer attitudes and appliance sales. They did this before and after conversion to assess the effects. For example, the NTGB carried out a survey of customer reactions to conversion (North Thames Gas Board 1968), while SoGB surveyed customers on appliance sales to assess the impact conversion was having on them (Southern Gas Market Research and Planning Department 1969, Southern Gas Market Research and Planning Department 1969a, Southern Gas Commercial Department 1969).

The boards also carried out surveys of customer trends in specific areas that had been converted, for example, the EMGB did one in Wellingborough after its conversion in 1968. This was one of the first areas in the country to be converted to natural gas and EMGB was keen to get feedback to improve future conversions (EMGB 1968).

8.5 The role of the showrooms and Home Service

At the time of conversion, the gas industry was vertically integrated, managing everything from production to through to sales. As such, there was a gas showroom in every town and city. These provided a place where customers could buy appliances, settle gas accounts and view demonstrations of gas appliances. The showrooms also formed a base for the Home Service, this important arm of the gas industry, worked directly with customers. Visiting homes to assist customers with their appliances. Many showrooms had theatres in which they carried out cooking and appliance demonstrations. The regional Home Service organisations laid out much of the groundwork for conversion for customers by giving talks, demonstrations, film shows and providing a point of contact, for those with queries.

An important role provided by the Home Service, was to ensure customers could cook with natural gas. This initiative was led by Edith Ballie, the Chief Home Service Advisor to NTGB. At the time of the conversion. The NTGB constructed a test kitchen fitted with natural gas-fired cookers in a hut on the Bromley by Bow gasworks before the Canvey Island conversion. Edith Baillie and her team carried out extensive trial to ensure Home Service advisers were able to cook with the gas and carry out demonstrations to others (Anon, 1982).

Figure 8.17. Home Service Advisors leaving their mobile kitchen (left) and demonstrating natural gas to an elderly customer (right). Source - National Gas Archive

Southern Gas operated a Conversion Home Service team (Figure 8.17), which had a role as “part social worker, part caterer, part guide and comforter”. Its job was to seek out and help those who might have difficulty coping with the issues conversion could bring. Often the elderly, who had used town gas for decades, were uncertain about natural gas. The team also visited the sick and disabled (Sutherland 1973).

To target visits effectively, the team would contact local social services, Citizens Advice Bureau or equivalent organisations to pull together a list of those who may benefit from an explanation of what conversion is about. They would then make a follow-up call after conversion to check everything was all right. One of the home service team, Sue Tye, said: “Most people are worried that natural gas is going to be too fierce – but all they’ve got to do is use it and they are happy.”. Many suggestions for visits came from the conversion teams who suspected equipment was technically sound but the user’s technique was not. At times when there was a dispute with the customer, a British Standard Baking test was be carried out to show where the fault lay. This team, consisting of Sue Tye and Sue Shorley, worked in every converted area of the Southern Gas region (Sutherland 1973).

8.6 Public relations and industrial conversion

In the early years of the 1950s when the industry's future was uncertain, it had focused significant attention on the industrial sector in an attempt to win new customers. The industry achieved this thanks to the intimate knowledge gas engineers had of their customers' plant and how best gas could meet these demands. These specialist industrial gas engineers in the regional gas boards developed strong links nationally, which eventually became coordinated by the Gas Council's Industrial Development Committee and the work of the Midlands Research Station (MRS). These close links were particularly useful in the future conversion programme in winning the confidence and goodwill of customers (Elliot 1980).

The gas industry was keen to attract new industrial customers as well as retain and convert existing industrial customers. To that end, the NTGB held an exhibition during 1965-66 at which it demonstrated 20 gas-fired steam boilers of different capacities to existing and prospective customers (Gas Council 1969).

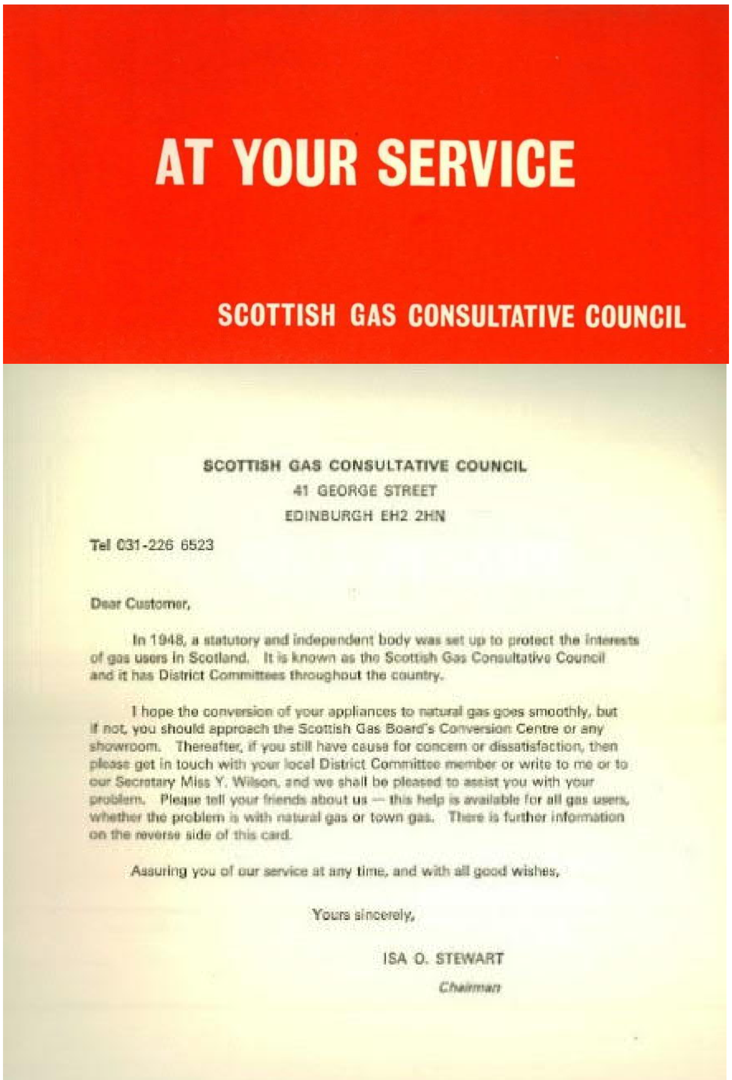
Another example of this is the WMGB industrial heating exhibition between April and December 1967 at its offices in Solihull, which featured a series of practical demonstrations of gas-fired plant. Similar events were held by the NTGB and EMGB, the latter holding the exhibition in Burton on Trent, which had been converted the previous year. Meanwhile, the SoGB had a mobile display unit for industrial conversions (Gas Council 1969).

In the spring of 1969, the industry established the Industrial Conversion Committee, which included representatives from all the regional gas boards, the Gas Council and the MRS. Its aim was to standardise industrial conversion across the regional gas boards (Elliot 1980).

8.7 Controversy and criticism

Consumerism had been on the rise for some years and one organisation that paid much attention to the conversion programme was the Consumers Association, which reported on it in its monthly publication *Which*. It had published a six-page report on natural gas as early as May 1967, which had a strong focus on surveys undertaken on Canvey Island following the pilot trial conversion there.

During conversion, boards sent their customers details of their local Gas Consultative Council (Figure 8.18). These consultative councils were set up to handle complaints that had not been resolved by the regional gas boards.



AT YOUR SERVICE

SCOTTISH GAS CONSULTATIVE COUNCIL

SCOTTISH GAS CONSULTATIVE COUNCIL
41 GEORGE STREET
EDINBURGH EH2 2HN

Tel 031-226 6523

Dear Customer,

In 1948, a statutory and independent body was set up to protect the interests of gas users in Scotland. It is known as the Scottish Gas Consultative Council and it has District Committees throughout the country.

I hope the conversion of your appliances to natural gas goes smoothly, but if not, you should approach the Scottish Gas Board's Conversion Centre or any showroom. Thereafter, if you still have cause for concern or dissatisfaction, then please get in touch with your local District Committee member or write to me or to our Secretary Miss Y. Wilson, and we shall be pleased to assist you with your problem. Please tell your friends about us — this help is available for all gas users, whether the problem is with natural gas or town gas. There is further information on the reverse side of this card.

Assuring you of our service at any time, and with all good wishes,

Yours sincerely,

ISA O. STEWART

Chairman

Figure 8.18. Card and letter sent to Scottish Gas Board Customers informing them of the Gas Consultative Council. Source - National Gas Archive.

Allegations were made in different regions regarding preferential treatment given to MPs, local councillors, leading figures in industrial or business organisations and local affairs influencers. These groups of people were allegedly assigned specially experienced fitters to ensure a smooth transition and changeover. The allegations were based on readers' letters to editors rather than investigative journalism and were strongly refuted by the regional boards concerned. In all sectors, however, there was a priority list of vulnerable people – elderly, sick and disabled people and families with young children. These lists were compiled with the help of social services departments and councils. (McCawley 1977).

Between 1,500 and 3,000 calls came into the gas boards in any week, depending on the sensitivity of the district being converted. The greatest number of calls experienced was over Christmas week in 1974 when, after conversion of the Knightsbridge and Eton square area, 3,500 calls were received and 36 written complaints to the chairman were dealt with (Collins and Green 1977).

Table 8.1. The complaints and associated resolutions to appliance conversion issues

Complaint	**Resolution**
Loss of simmering on cookers (lowest stable rate)	Production of improved forms of tap giving better turn down
Noise due to substitution of aerated burners	Introduction of bar burners using multi-hole injectors and operating at lower pressures
Poor ignition	Introduction of more robust igniter heads operating at higher potentials, in some cases, using transformed AC current. Introduction of reliable impact or piezo ignition devices that are also low maintenance other than the attention to spark gap
Pilot instability	Use of improved pilots incorporating flame retention.
Balanced flues	For balanced flues, the concentric terminal is useful in combating vitiation (reduction in quality) problems
Linting and sooting due to the reduction of primary air supply to aerated burners	Regular servicing. Development of lint-resistant burners by Watson House

To investigate the high volume and necessary corrective action, district surveys were conducted by members of staff of Watson House. Between the start of conversion and August 1969, they carried out 15 major surveys to identify the main complaints. These included an examination of the same appliances before and immediately after conversion, an analysis of call-back complaints during the eight-week post-conversion period and checking converted appliances that generated no complaints. As a result of these surveys, boards introduced a number of modified and improved conversion sets called “phase-change sets” (Byford *et al* 1977).

There had been considerable distrust about the competence and training of the converters, which was misplaced due to the intensive training regime they all underwent and the incentives linked to low rate of call backs (Richardson 1977).

Language barriers with communities where English was not spoken as a first language were overcome by publications in other languages such as Urdu, Bengali and Punjabi, including a 20-minute documentary titled ‘The Age of Conversion’ which was dubbed (McCawley 1977).

The height of issues with the media occurred around 1970, toward the start of the programme as it ramped up in intensity. The gas industry generally and conversion in particular was going through a bad patch with the media. Natural gas had become big news and there had been a few accidents throughout the country where deaths had been caused by it. Gas was generally considered to be the fuel with the best safety record and there was no evidence to show any increase in the number of accidents after conversion to natural gas. However, while natural gas was a popular topic, almost any incident would make the news (Anon 1970a).

The South Eastern Gas Region of the British Gas Corporation (SEGAS) felt there was unfair bias against gas in the media. The industry was proud of its reputation and took note of what the press was saying if criticism was justified. While it was obvious no householder was going to like conversion as it was happening because it inevitably meant a certain amount of inconvenience, most of customers were converted with little trouble and were happy to be on natural gas when it was all over. In 1970, SEGAS was converting 3,000 customers each week and most were delivered without issue. However, some jobs did not go according to plan and they were the ones that inevitably got into the papers (Anon 1970a).

Many of the recurring problems across the country during conversion were only indirectly connected with it. They were nearly all associated with the sub-standard installation of flues or ventilation of gas appliances, legacy issues that were identified by conversion fitters. Other issues related to converters’ refusal to convert portable gas fires. Despite safety being the valid reason for this, the issues received considerable press coverage nationally and in the regions. This led McCawley (1977) to question the effectiveness of some of the communications provided by the industry and perhaps the safety message should have been more strongly enforced.

Substandard installations were an irritation for the conversion fitters as well as the customer. The fitters had to rectify these safety issues, which had nothing to do with their work, and it would usually result in a cost for the customer. For a campaign promoted on a claim conversion would cost customers nothing, this did not sit well. Customers could also be left without heat for long periods while negotiations were held over who should pay for the work, especially in the case of tenants (McCawley 1977).

The East Midlands Region of British Gas Corporation (-EMGAS) was taken to court on two charges under the Trades Descriptions Act due to its refusal to convert portable gas fires. The prosecution said that, by refusing, EMGAS was contravening the phrase in their conversion brochure: "but in some cases, if age or design made conversion impracticable, we will replace the appliance with a similar one completely free of charge". In defence, EMGAS stated their decision was not contrary to the phrase and the decision not to convert portable gas fires was a policy decision taken after the brochure was published and had been made for safety reasons because the fires were deemed dangerous. EMGAS was acquitted by Leicester magistrates, but as the first prosecution of its kind in the country, the case affected the whole gas industry (McCawley 1977).

Summing up and the end of his paper, McCawley (1977) stated that the industry's public relations advisers will never again be charged with the task of taking their customers through such an intimate and difficult period of change. In a paper to the Yorkshire Junior Gas Association, J.R. Finnigan, The Conversion Manager for the NEGB stated: *"If conversion is not underestimated, there is good planning, adequate facilities, a high degree of technical ability and manual dexterity, coupled with a will to win, then conversion is easy."* (Finnigan 1969)

8.8 Tributes and customer letters

The effective delivery of the conversion programme did not go unnoticed, with the Under-Secretary of State for Energy Gordon Oakes saying: "I should like to take this opportunity of praising the gas industry for the miracle that it performed in converting the country from town gas to natural gas. It was one of the smoothest operations of the kind in the world. Of course, there were accidents and complaints. Every hon. member received letters from aggrieved consumers, but we put the number of such complaints at one in 1,000. The remaining 999 consumers were perfectly happy with the fuel being supplied to them" (McCawley 1977).

The 37 people who worked on the conversion programme and responded to this project's questionnaire were asked "Do you think this was an accurate reflection of the conversion programme?". Some 27 responded in support of the comment, some felt the hard work and dedication of the workforce was not appreciated. Others who worked on post-conversion support highlighted the amount of call-back work to rectify errors made during conversion and the number of complaints may have been higher than recorded.

Gordon Oakes' statement was followed up with comment from MP Peter Bottomley (Con. Woolwich West), who said: *"I should like to confirm what the Under-Secretary said about the natural gas conversion which went through my constituency not quite like wildfire but very smoothly. Only three problems were raised with me, all of which the South Eastern Gas Board cleared up quickly. A tribute to the people of the gas board and its contractors is due from this House. I should very much like to associate myself with what the Minister said."* (McCawley 1977)

Many favourable letters were received from customers and examples are given below:

METICULOUS CARE This letter was received last month by the manager, Guildford District, from a customer at Merrow, near Guildford: "Dear Sir, I received, and appreciated, your "card of thanks" this morning. This gives me an opportunity of expressing to the Board my thanks for the meticulous care with which you carried out your recent conversion programme, which must have created a most favourable impression with your customers. I speak with some experience, as a director of a well-known Public Company, in offering my congratulations on the way in which this complicated manoeuvre was carried out. Yours truly, Edward W. Snowdon" (SEGAS Magazine p2, February 1970).

"After reading about the couple who waited nine weeks for a fitter to repair their faulty gas stove, I feel I must rush to defend the gas board. The regulator on my gas stove jammed and I was unable to turn it off. At 2pm I rang the gas board. Being a Sunday I never expected to get the wonderful service that followed. Exactly 30 minutes later, a fitter arrived." (Mrs.) H. F. Budd, New Maiden, Surrey. (Reprinted from the *Daily Express* and featured in SEGAS Magazine p2, February 1970).

"Your staff has been absolutely magnificent. No effort seems to be too much, and the members of your staff have taken a personal interest in solving the problem. This has not been the attitude of someone who just looks forward to finishing time. They have been extremely helpful in every way." Mr. J. A. Jenkins of Botcherby (Norgazette 1970).

"I would like to record my appreciation for the intelligent way in which the conversion of the essential gas-operated equipment in my business was handled by your engineers.

There is at least one individual who is grateful for a conversion job carried out with the minimum of disturbance and a great deal of thought." Mr. R. M. Hetherington, Armstrong, Confectioners and Caterers of Carlisle (Norgazette 1970).

"How fortunate we have been in the good service rendered to us at the Deanery. There have been many problems to surmount (especially with the gas-fired central heating), but the men had given such willing and excellent service, and nothing seemed too much trouble for them. They worked late into the night, and we were struck by their skill and courtesy." The Dean of Carlisle (Norgazette 1970).

The questionnaire instigated as part of this project asked: "How effective do you think the communications were surrounding the conversion programme and the reason for converting to natural gas?". The responses were on a scale of 1 (not effective) to 5 (very effective) and came back with 87.9% responding either 4 or 5 and 12.1% answering with a 3. This suggests that, for those working in the gas industry on the conversion programme, the communications were considered effective to very effective.

9 We are all natural now - the completion of the project and expenditure involved

Many of Britain's 14 million gas customers found it hard to acknowledge and appreciate the significant success the completion of the mammoth conversion programme represented. After all, conversion had been unsought and unwanted and the benefits were not immediately evident to customers. While the understanding of this mammoth project may not have been evident, amid some public concern, there was tremendous cooperation provided by various authorities and patience shown by customers.

On 1st September 1977 in Edinburgh, Scotland, a ceremony was held just before the final conversions (Figure 9.1), Sir Denis Rooke, the chairman of the BGC, thanked customers for their co-operation during "Perhaps the biggest peacetime operation in this nation's history". Describing the scale of the conversion project as astonishing, he stated: "While we who worked on the job are congratulating each other on its successful accomplishment, we should not forget our customers. The biggest vote of thanks is surely due to them." (Anon 1977a)

The initial estimate based on the conversion costs in other countries and the industry's own data, was £30 per customer with a total expenditure of £400 million (Smith 1977). The actual total expenditure was around £43 per customer and more than £560 million (Elliot 1980).

The £1 billion cost of converting Britain to natural gas, had been paid for out of revenues by the British Gas Corporation by 1977. The total cost had been £600 million which, considering inflation, was below the original £400 million forecast at the start of the programme. There was an additional cost of £400 million incurred when the value of gas making plant made obsolete was included. Denis Rooke concluded "The whole of that sum will have been written off against revenue by the end of the current financial year. This means that the entire job will have been paid for by the industry out of the income it has received from its customers, without subsidy of any kind." (Rooke, 1977).

Figure 9.1 Denis Rooke, with the sector conversion staff (Mark Hampson, John Young and Jim Borthwick) at the conversion base at Great Junction Street, Edinburgh in 1977 as conversion nears completion. Source - National Gas Archive.

This had not been the case overseas, where it generally entailed major financial restructuring and, in some case, even bankruptcy (Anon 1977a).

The exploitation of North Sea gas was estimated to be saving the UK £1 billion per year and the Treasury Economic Progress report of July 1976 estimated the overall effect on the balance of payments could be as much as £8 billion by 1985 (Boost 1976). In the West Midlands region of the BGC, the Chairman David Beavis reflected to his staff: “In the past, gas has played an important part in this country’s fortunes and if those figures are a guide, its role in the future is to be an even more vital one. I know that we in the West Midlands will look forward to the challenge this role will bring, and I know we shall succeed as we did with Conversion, Many thanks to you all.” (Boost 1976). The West Midlands region produced some interesting statistics on its conversion programme, which was one of the most complex. It inserted 5,000 valves in 18,000 km of gas mains. The region had been split into 514 sectors, which had between them 25,000 flare-off points. Its 1,276,035 customers were split into 1,233,980 domestic customers, 35,714 commercial customers and 6,341 industrial customers (Boost 1976).

The overriding memory of John Shuttleworth, the assistant regional service manager with overall responsibility for conversion, was: *“The spirit of teamwork and enthusiasm was one of the most memorable things for me about conversion. Staff, faced with great problems, put in a tremendous amount of hard work. There was a real desire to give the customer satisfaction and the length of time they had to work didn’t matter.”* He went on to comment: *“It will be a pity if all the friendships which have been formed during conversion have to end as the conversion staff are split up. Conversion has been eight years of my life which I would not want to have missed. We will never convert the West Midlands again and It was a unique experience for all of us.”* (Boost 1976)

In the 1976 Wales Gas retrospective on conversion, the great changes that had occurred after nationalisation were acknowledged: *“In 20 years, the gas industry in Wales had seen two revolutions – from making to taking (coke oven gas); from coal to oil; and now it was to see a third, more basic than either of its predecessors, from manufactured to natural gas… the North Sea gas.”* (Wales Gas 1974).

Patrick Gallacher, the Chairman of Wales Gas, reflected: *“Conversion has not been without its problems, and we have never underestimated or under-emphasised these. The many problems have placed a strain both on our customers and on ourselves. Now the work is complete, a new era in the history of Wales Gas begins. The industry may now look forward to playing’ yet more important part in the future prosperity of Wales. Finally. I would like to thank not only my staff. and that of our Contractor, but also all those in government, local government, industry and commerce and most of all our domestic customers for their co-operation in ensuring that this adventure into the future* *has been brought to a successful conclusion."* (Wales Gas 1974). Thanking domestic customers was a common theme running through all the speeches of the BGC staff.

While the conversion programme in Wales had cost £22 million, it would have cost twice that figure if conversion had not happened. Natural gas led to a 2.5% drop in domestic gas prices and domestic, commercial and industrial sales had increased 66%, 75% and 463% respectively by 1974. It led to a position where Wales Gas sold more gas to the steel industry than it had taken from it in the form of coke oven gas (Wales Gas 1974).

The Chairman of Scottish Gas, Maurice Redman, praised the Scottish Public for their patience and co-operation during the conversion programme which moved through Scotland in seven years and came to an end in September 1977, he was quoted as saying: *"The assistance that Scottish Gas received from the public has been crucial. we are particularly appreciative in the co-operation in getting into people's homes to carry out the conversion work. This is surprising in view of the increasing number of women who now go out to work"* (Redman 1977).

In his address to Scottish Gas at the end of the conversion programme in 1977, Maurice Redman gave special mention to the Scottish Gas Consultative Council. He was particularly keen to pay tribute to its staff, its former Chairman Mrs Isa Stewart, who was in office when conversion began, and the Chairman at the end Mrs Jenney Buchan. *"There was a great increase in their workload as a result of conversion,"* said Maurice. *"And their forbearance, understanding and build-up of knowhow on conversion problems was to be admired."* He also stated that Scottish Gas always tried to be responsive to the Council's inquiries and commented that the Council gave strong support for the unjustly or badly treated customers but none for unreasonable people. He described the relationship between the two organisations as a 'dialogue' and said this was what consumerism ought to be about*: "Not a knocking match but a constructive dialogue dedicated to improving the gas service."* This relationship between gas consumer and Scottish Gas was recognised by 'Justice', the British section of the International Commission of Jurists. (Redman 1977). Maurice Redman commented that the main consequence of natural gas conversion to the Scottish gas consumer has been the convergence of gas tariffs nationally. Customers in Scotland paying the same for gas as most customers in England and Wales (Redman 1977).

The conversion was also good for the industry. Between 1949 and the end of the conversion programme in 1977, British Gas sales increased sixfold. The increased installation of central heating into domestic properties was a direct consequence of the conversion to natural gas (Richardson 1977).

Figure 9.2 Robin Marshall flaring off gas in Alston (left) and Ronnie Brockbank opening the valves to turn on the supply of natural gas in Kirkby Stephen following the conversion from LPG/air (Right). Source - National Gas Archive.

Conversion did create some unexpected consequences, perhaps the most challenging being the impact that switching from a wet town gas to a dry North Sea gas had on the mains network (as described in section 4.2.) which caused the jute and rubber-sealed joints to leak. The problem was eventually rectified from 1967 with the addition of oil and monoethylene glycol fogging units, swelling the jute and making the rubber supple and sealing the joints once again. Another issue was natural gas had no distinctive smell like town gas. The distinctive smell was a useful safety feature, so the industry introduced low levels of an odourant made from tertiary butyl mercaptan and dimethyl sulphide into the supply of natural gas.

Even though the main conversion programme ended in 1977, the whole of Great Britain had not been converted. Towns such as Bala in Wales and Alston in Northern England were still not connected to the gas network and had to be supplied by alternative means, meaning a switch to Liquid Petroleum Gas (LPG) mixed with air. Experience gained from converting the town of Whitland in south west Wales to LPG/air in 1952 had been useful in converting these towns as a stop gap measure (Jones 1958, Anon 1987).

In these towns, the old gasworks were closed and replaced by an LPG/air mixing plant. The composition of this gas was different both to town gas and natural gas: it was heavier than air, which meant any leaks could build up in basements, depressions or at ground level, creating the potential for an explosion. These towns continued to operate isolated from the main gas network and used this different gas for more than 10 years. They were later converted when the pipelines had been built connecting them to the natural gas network. The conversion ceremony held at Alston (the highest town in England) in 1987 is shown in Figure 9.2 (Anon 1987, Jones and Reeve 1978).

The supply of LPG gas (such as Glogas) to off-grid customers was common in many of the regional gas boards, especially those with many remote communities such as NGB, SWGB, WGB and ScGB.

Eastern Gas had supplied propane to villages in the Chilterns, which had not previously had a supply from a gasworks. The board hoped the load would be significant enough to justify connection to natural gas. Eventually conversion to natural gas was driven by increased safety requirements for the propane storage sites and the increased costs of the fleet required to supply these sites (Barber 1980).

Not all town gas networks survived. For example, the gasworks at Seascale in Cumbria, Golspie in Sutherland and the last coal gasworks to close in Britain at Millport on the Isle of Cumbrae were examples where the gasworks was closed and the mains gas supply abandoned. A supply of bottled gas was provided, but this hardly made up for the convenience of a mains gas supply. The overriding decision for abandoning these networks was economic as they were a long way from the gas network and the amount of gas supplied and the number of customers was relatively small. It still brought great inconvenience to the public and was very unpopular.

Some parts of the gas network were economically viable but were not cost effective to connect to the gas network due to their remote location. These still operate today and are known as Statutory Independent Undertakings (SIU) because they are independent of the rest of the gas network. There are two in mid Wales at Llanfyllin and Llanwrtyd Wells, which operate on LPG and four in Scotland. The SIU’s that supply Campbeltown and Oban switched to LNG in 1974 and 1972 respectively. The nearby towns of Thurso and Wick, which form one SIU, were originally converted to butane/air in 1969 but were switched to LNG in 1982. These were supplied by LNG delivered by road tanker or rail. The SIU in Stornoway on the Isle of Lewis was originally supplied by butane/air, but was converted to propane in 1996, which was supplied by ship. On each site, the liquefied gas is vapourised on-site and supplied to the local gas network. The Stornoway SIU was the last major conversion of the British gas network, undertaken after British Gas had been split up and many of the in-house services that had been available during the natural gas conversion programme were no longer in existence.

The conversion was driven by both the lack of choice of appliances suitable for use with the 625 btu/ft^3 (23.3 MJ/m^3) butane/air gas supplied and by the requirement to replace the ageing plant. The decision to replace with propane offered consumers a greater choice of appliances. The experience of the person in charge of the conversion operation, Finlay Macdonald, mirrored many of those noted in the natural gas conversion programme. The conversion process followed the same pattern: sectorisation of the network into areas containing between 150-200 customers, surveying appliances in premises and adding filters in front of the gas meters, which were often replaced. Conversion was undertaken in two stages, with an initial conversion of about 20% of the customers in December 1996 to reduce the load on the butane/air plant during the winter and then a restart of conversion the following April. Unlike the conversion to natural gas, appliances were replaced rather than converted, providing the customers with new like-for-like appliances or through upgrade at an additional cost. The conversion team faced challenges with the state of gas installation in some properties, such as incorrectly fitted flues, and commercial appliances also proved complex to convert (Finlay Macdonald Personal Communication).

Those who played a key role in the conversion programme would ultimately benefit from the experience and both the regional gas boards and the Gas Council picked their most capable staff for the roles. Many of those involved in the conversion programme later attained senior roles in the regions or national structure of the British Gas Corporation. This included Keith Summersgill, who was originally in charge of conversion in the NWGB and later became Deputy Chairman of East Midlands Region, and Ken Penhaligon, the Conversion Manager of the SoGB who later became the Deputy Chairman of the North Eastern Gas Region. Sir Denis Rooke, one of the most notable engineers the British gas industry ever produced, was involved with the switch to natural gas from the first voyage of the Methane Pioneer through the conversion programme to later becoming the Chairman of the British Gas Corporation (Elliot 1980).

After conversion, Harold Lipscombe of Scottish Gas commented: “The future now heralds a new era – within the next two years the UK will become self-sufficient in energy, a position it had lost when it had moved away from the use of coal to imported oil for gas production. Gas will be making a major contribution to this by taking over the main space heating load, with Frigg on stream, we are at the springboard of enterprise, the gas industry is moving towards a position when it will capture 50% of the domestic market and attain an exceptionally rapid increase in industrial business, with priority being carefully preserved to promoting gas for those uses where the fuel’s premium use, qualities of purity, rapid heat release and controllability are best suited."(Lipscombe 1977)

When Elliot (1980) reflected on the future of the gas network in the preface of his book on the conversion programme in 1980, he did not foresee a need for a future conversion programme, a view also held by McCawley (1977). Elliot believed a future reversion to gas manufacture would occur, not to town gas but to Substitute Natural Gas (SNG). This view was also held by Lister *et al* in their paper from 1981, in which they suggested after the decline of local natural gas, a switch to SNG, derived from the hydrogenation and methanation of fossil fuels, would be the next move. This was before the realisation of the climate emergency (Lister *et al*, 1981). While hydrogen was not considered in this paper other than is its involvement in SNG manufacture, the use of hydrogen as an energy carrier had featured in a paper presented to the Institution of Gas Engineers in 1979, by G.F. Donat of Gaz de France. Donat identified the need to move away from dependency on foreign hydrocarbons and look to nuclear or solar. The challenges with the storage and transmission of these energy production methods at the time of need identified hydrogen as a potential energy carrier (Donat 1979).

10. Questionnaire responses

As part of this project, a questionnaire was sent to those who worked in the gas industry during the conversion programme. It included 11 questions, though not all questions were answered by each respondent. One of the aims of the questionnaire was to seek opinions and to assess whether the executive summary of this report reflected the views, experience and memories of those who worked on the conversion. Most respondents agreed it did, although some highlighted other points not included in the original draft of the executive summary. These have either been amended in the executive summary or recorded elsewhere in this report. Some 37 people who had worked for 10 of the 12 regional gas boards (Scottish and Southern Gas Boards were not represented) responded to the questionnaire. Of these, 27 worked in regional gas board conversion departments, while three others were a senior gas technician, gas fitter and gas service engineer during conversion. Four respondents were working in the regional gas board storage and distribution departments, with one other working in gas transmission and another in a finance or accounting role. Some 31 of the respondents had worked on domestic conversion, with one working on industrial conversion and none working on commercial conversion. Five worked in other functions in the gas industry. The questionnaire included five long answer questions, which are described in this section, with others reported at the appropriate points elsewhere.

10.1 The key learning from the conversion programme

The questionnaire asked: “What do you think was the key learning from the conversion programme?” The most numerous responses focused on the logistics of the conversion programme, with one respondent stating: “Unquestionably, the logistics which required close coordination between network planning and district operations and the contractors (Wm Press in EMGB) who carried out all the downstream work and interfaced with customers.”

The next most popular response was the technical learning accumulated during conversion and being able to adapt and adjust appliances to work correctly on natural gas. New challenges that needed rectifying immediately were faced daily, aided by appropriate technical and managerial support. This also included the technical quality of the customer surveys, which ensured the correct conversion kits were ordered. Some, however, highlighted the challenge from the discovery of substandard installations and products, which, once rectified, enabled an upgrade of the entire gas infrastructure. A similar challenge was the need to convince customers to have their appliances serviced at regular intervals, since so many had been identified as in a poor state during the conversion programme. One industrial gas engineer highlighted the challenge of learning about the properties of natural gas, which were different from town gas, when converting industrial appliances. For example, some of the changes you could make with town gas such as increasing pressure were not effective with natural gas.

Other popular responses included the improvements made in customer service, which adapted as the engineers grew with experience. Good communications were also paramount, especially on conversion day, and for logistics in ensuring every house had been surveyed and correct parts were ordered and delivered. This required excellent interdepartmental communications but also close links with wider stakeholders.

Another key theme was the benefit of being a vertically integrated gas industry, which could create local multi-disciplinary teams with a clear focus on what had to be done for the benefit of our customers, the gas industry and the nation. This enabled a loyal and motivated workforce on the ground that knew the objectives and was able to use its initiative to overcome problems. One respondent commented: “While much of the conversion went smoothly, these teams showed remarkable resilience when things wrong, as they were almost bound to do at times given the complexity of the total operation nationwide.”

10.2 The biggest challenge of the conversion programme

The questionnaire asked: “What do you think was the biggest challenge of the conversion programme?” which provided a range of answers, many similar to the previous question. These were largely focused on communication, dealing with old appliances, safety, planning and logistics and staffing issues.

Respondents highlighted the importance of correctly identifying appliances during surveys, which was particularly important due to the huge variety in the types and models of appliances and therefore the associated variation in conversion kits. One challenge was that the ‘Sell Out’ offer from the gas showrooms enabled people to change their appliances after the survey and before conversion day. If the gas board were not informed, the engineer had the wrong conversion kit to adjust the appliance.

Older domestic appliances were a particular problem, with some dating back to the 19th century and some in poor condition, while some households had gas but no electricity, adding a further complication. These old appliances often required ad hoc bespoke conversions due to there being no suitable alternative appliance on the market. These conversions were typically undertaken in the mobile or regional workshops, depending on the complexity of the task.

Customer communication and persuasion was another key issue raised. Good communication with the customer was vitally important to get the message across that the engineer would need to access to their property to undertake surveys, pre-conversion work and the necessary adaptation of their appliances during conversion. Convincing customers conversion to natural gas was for the best and modifying appliances was a necessity could be a challenge. This was made more difficult by the negative national and local publicity from increasing post-conversion problems that occurred in some locations.

Working hours and staffing were highlighted by many respondents. This included both early starts and staggered late nights during sector testing. There were also long working hours to keep up with unforeseen support requirements, which led to lots of overtime. Low staffing levels that could have had an impact on the programme were raised by several respondents. Getting the conversion work done in a safe and correct manner and not inconveniencing people was a challenge, especially where there were unforeseen situations such as unsound gas installations that needed to be rectified first.

Another common theme was conversion planning and coordination. Management of the logistics and coordinating materials and engineers to be in the right place at the right time could change on a daily basis. It was not just the delivery of the conversion programme but managing it alongside the day-to-day work that was a challenge. Also posing problems was the sheer scale or the conversion programme and the repeated challenge of getting it right week in, week out.

10.3 Customer attitudes to the intrusion in their home/premises

The questionnaire asked: “How did customers approach the intrusion into their homes/premises during the conversion programme? Did you have experience of being refused entry, in which case what action was taken?”

Most engineers said they had not been refused entry or that it was rare to be refused entry. The few customers that did refuse were usually persuaded when it was explained their gas supply would have to be cut off otherwise. Some had to be cut off as the premises were vacant or the owners were on holiday. One respondent who had worked in inner city areas said these had provided a greater challenge with access and cutting off gas supply would happen more often. It would usually have to be cut off in the footpath as outside meters were not common. Customer service would then contact the customers to arrange conversion and reconnection. An engineer who had worked on the Burton on Trent conversion said customers were positive about being pioneers of the new natural gas. One noted that, for surveys, they sometimes would have to return later if customers were at work in the daytime. Good communication was again highlighted as key in ensuring access was granted to homes.

10.4 Concerns over the condition, maintenance, and installation of gas appliances

The questionnaire asked: “The conversion programme identified significant concerns over the condition, maintenance, and installation of gas appliances. Did you experience this during your work, and can you provide any examples?”

All but one respondent who had been involved in converting appliances experienced issues with appliance maintenance and installation of gas appliances. The most numerous issues were poor and dangerous installation of appliances, especially around the flues and ventilation, which did not meet regulations. Some examples given were appliances venting into a cavity or adjacent room rather than outside and poorly installed water heaters. Many customers would not accept their appliances had been installed incorrectly or were unsuitable for conversion. Common customer objections were: “It’s been fine for 10 years; you’re not touching it!” or “You’d better be doing it for no cost!”. One engineer commented they still found appliances years later that had not been converted.

The conversion highlighted the lack of maintenance on many appliances, which showed the need to convince customers to have their appliances serviced at regular intervals. On boilers, this caused a lot of sooting problems and pilot outages. Call backs were frequent and increased workload, while post-conversion work was challenging, with poorly converted or un-serviced appliances.

Age of appliances was also a concern. One engineer noted there had been a push during the pre-conversion governor installation and filter replacements to report appliances and installations deemed unsafe. There were considerable numbers of other appliances (mostly obsolete) customers wanted converted, despite their condition, and some would take hours to convert. Where it was not possible to convert appliances, replacements were offered. Old cast iron cookers in many cases were replaced with what was commonly known as ‘washed down Londons’ (white enamel cookers).

Another engineer responded: “Yes. I was involved in the preliminary survey of domestic premises in Burton-on-Trent and often came across appliances, mainly very old radiant gas fires, which were not listed in our appliance identification manuals. There were also instances of unsafe pipework and gas meters in the strangest of places. It also became apparent early on that meter reading records were not going to be enough to identify where gas was being used. Every premises, whether registered as a gas customer, had to be visited and checked just in case.”

One distribution engineer commented it had a similar effect to the distribution network. Another commented on the poor condition of mains in acidic soil, lead pipe and poor lead-to-copper transitions. Some of the old lead pipes couldn't take the pressure and was porous. Gas leaks were not uncommon, so replacing the pipework was sometimes undertaken before conversion.

10.5 How did customers adapt to using natural gas?

The questionnaire asked: “How did customers adapt to using natural gas? Were customers reluctant to change and did they prefer town gas or were they happy to adapt to the new gas?” Most respondents said customers adapted well and were happy with the change to natural gas. Although people didn’t like change, they accepted it, some reluctantly and some thought it completely pointless. One respondent stated: “The 1960s and 1970s were decades of change and most people seemed to accept that many things they had grown up with would change – mostly for the better. Natural (or North Sea) gas was initially seen as an interesting and exciting progression and we all gradually got used to it.” A couple of engineers pointed out the customer did not really have a choice, while another responded they received mixed views from customers. One engineer reported there were many customers disappointed after conversion, with the main problem caused by the properties of the new gas: glass tubes, pilot outage, glow coils, cross-ignition, oven temperatures.

In the main, customers were happy to have a safe gas supply and a free overhaul of their existing systems and appliances. Most appliances were operating satisfactorily post conversion and the owners of those that failed to be converted were given generous subsidies to change to a new appliance. Customers only noticed small changes in the gas characteristics, but appliances mostly worked much the same as before conversion and people wondered what all the fuss was about.

Some engineers commented that most appliances worked better than before and, where there were problems, they tended to relate to lighting the natural gas or pilot light failures. Some complained of the noise from new gas fires such as the Canon Miser. There were a few complaints natural gas wasn't as controllable as towns gas, but most consumers quickly got used to it. One engineer stated: “I found most were happy to adapt and when things went wrong, such as pilot failures or problems with the cross lighting tubes, they joked that the tide must have gone out or there’s a mackerel stuck in the system.” A minority of customers were afraid of natural gas due to reports of accidents and a fear of natural gas being more explosive and/or toxic than coal gas. Things changed when customers realised how safe the fuel was and, with newly developed appliances with safety devices, confidence grew in the customer base. Concerned customers were quickly pacified by experienced call centre staff and a good backup team of Home Service advisors who worked alongside the conversion units.

The significant up-take of gas central heating post conversion suggested customers soon adapted to natural gas, with many 1950s ‘all-electric’ estates adopting gas. Gas central heating changed 'home comforts' enormously.

11. Conversion programmes undertaken abroad

The conversion programme in Australia was mentioned in two reports that have been reviewed. Smith (1977) mentioned that, in Australia, the programme for the State of Victoria and Melbourne was completed in 21 months and converted 436,000 customers. The subject of the gas conversion was reviewed more recently by Bond and Veitch (2020). In the 1960s and 1970s, many Australian towns and cities transitioned from town gas to natural gas. State governments mostly built gas transmission pipelines, supplied the gas from the production field to the major cities (Bond and Veitch 2020).

As in Great Britain, the conversion programme in Australia was a huge logistical and technical undertaking. In Melbourne, the Gas and Fuel Corporation deployed a team of 800 staff to visit 435,000 households and convert 1.25 million appliances. The process took 18 months and was estimated to have cost around $350 million in today's terms. Despite extensive preparatory work, things still went wrong. As had been encountered in Britain, during the early days, the corporation's targets were too ambitious, resulting in hundreds of call-backs to fix faulty conversions (Bond and Veitch 2020).

Some converted appliances did not behave as expected and few engineers had much experience with conversions. One poorly converted room heater left two people in a coma (one of whom eventually died) due to carbon monoxide poisoning. This resulted in the banning of unflued gas heaters in Victoria (Bond and Veitch 2020).

Gas companies also had to contend with apprehension or disinterest from customers. In Adelaide, for example, the South Australian Gas Company surveyed 300 housewives before the conversion process and discovered that natural gas had a serious image problem. In response, the company invested more than $100,000 ($1.2 million in today's terms) in a publicity campaign to inform customers about what to expect from the conversion. In Sydney, delays in pipeline construction meant natural gas did not arrive until 1976, much later than anticipated. Faced with ambivalence and even cynicism from its customers, AGL reinvented itself through a massive and highly successful marketing campaign dedicated to 'the living flame' (Bond and Veitch 2020).

The key lessons Bond and Veitch (2020) highlighted from their study of the conversion of the gas network in Australia were:

- Expect the unexpected. No amount of laboratory testing or planning can prevent unexpected problems from emerging when a new fuel is deployed at scale. Delays result.

- Conversion requires communication. Proactively engaging customers before, during and after a major conversion process will help ensure issues are identified and addressed quickly and effectively.
- Times have changed. Managing a large-scale conversion programme is likely to be more difficult today than 50 years ago. Trust in government is at an all-time low and gas companies are not highly trusted either. Gaining access to households will also be more difficult now that fewer people stay home on a full-time basis. And finally, safety incidents and installation problems could be broadcast via social media, potentially becoming a series of public relations crises.

Smith (1977) aisd that, in the Netherlands, two million customers were converted in a 4.5-year programme between 1964 and 1968. However, the discovery and use of natural gas predated this. In 1948, natural gas was found near the Dutch town of Coevorden by the Nederlandse Aardolie Maatschappij (NAM). Similar finds followed in 1950 at Tubbergen, De Wijk and the north of Overijssel. The gas was initially seen as a problem associated with the oil NAM was prospecting. In 1950, NAM concluded a contract for the supply of natural gas to the town of Coevorden. This idea was initiated by the director of the town’s private gas company, who realised it was an opportunity to cease the production of gas with their ageing gasworks and switch to distributing natural gas. In September 1951, the supply of natural gas began. Appliances could not burn natural gas effectively because of its higher calorific value and a similar problem was observed in those parts of the Netherlands that had adopted refinery gases. Two options were available, either to dilute the rich gas with a ballast gas such as nitrogen or convert the appliances to burn natural gas. While a decision was made to dilute the refinery gas provided in some parts of the Netherlands, in Coevorden and other small towns, a decision was made to convert appliances to natural gas (Verbong and Schippers 2000).

The development of regional transmission system happened in the Netherlands earlier than in Britain. This was due to a few major suppliers of gas such as the Staatsmijnen (State Mines), the Shell refinery at Pernis and Hoogovens Steel Works having surplus gas that could be distributed to regional towns cheaper than they could produce in their gasworks. The regional gas transmission systems that developed to supply this surplus gas eventually grew to a size that could be combined into a single entity. A State Gas Company had been proposed in 1953, which would be the successor to the earlier National Gas Supply Agency. This company, which eventually formed in 1957, would be responsible for the purchase, sale and transport of coke oven gas and natural gas. By the late 1950s, the Dutch gas network had reached 70% of the population, where it was mainly used for cooking (Verbong and Schippers 2000).

A year later, the NV Nationale Gasmaatschappij was formed, owned by the three main gas producers (Staatsmijnen, Hoogovens and the Staatsgasbedrijf), three large municipalities that produced gas at their own gasworks (Amsterdam, Rotterdam, and The Hague) and six regional bodies that worked together to produce gas. The discovery of the Slochteren natural gas field and the massive gas reserves they provided in 1959 pushed the Netherlands into the direction of natural gas and away from coke oven gas (Verbong and Schippers 2000).

After years of political discussion, a Dutch national gas transmission company called NV Nederlandse Gasunie was founded in April 1963. A month later, NAM received the concession to extract gas from the Slochteren gas field. Gasunie was given access to the existing regional gas transmission pipelines, which they eventually purchased and developed into a national gas transmission company (Verbong and Schippers 2000). Its role was equivalent to that of the National Gas Transmission System developed in Britain, supplying natural gas to the regional gas distribution networks. This transition was complicated by the fact both the State Mines and Hoogovens supplied their coke oven gas through their transmission systems. By switching the transmission systems to Gasunie and natural gas, these companies lost their market for selling coke oven gas externally, except for nearby industrial customers, for which they were compensated. In the early 1960s, the gas distribution companies that were not included in Gasunie formed six regional organizations and an overarching Commission for Cooperation of Regional Organisations for Gas Supply (SROG). It had been envisaged nuclear power would become the long-term source of energy in the Netherlands, so while natural gas was available, the government believed it would be better to extract the natural gas as extensively and quickly as possible before the switch to nuclear power (Verbong and Schippers 2000).

During 1964, a Planning Conversion Commission was established to convert the Netherlands to natural gas. The gas distribution companies were sent a questionnaire requesting information about the number of connections to be converted, the planning per municipality and the companies that intended carrying out the conversion. This enabled the Committee to conceptualise the work needed. A main conversion plan had been produced by the end of 1964, which set out the order in which the municipalities would be converted, the type of work undertaken and the time it would take to complete. A working group produced a list of approximately 5,000 types of cooking and heating appliances in use in the Netherlands. Most of the research work was undertaken by the Gas Institute (Verbong and Schippers 2000).

Conversion surveys were undertaken in each premises to make an inventory of the gas appliances used in each premises. A similar ‘Sell Out’ approach as later used in Britain drew consumers’ attention to the possibility of exchanging old appliances for new ones.

This approach was also partly promoted on safety grounds with about 1.7 million old gas appliances being replaced by new ones, leaving 3.3 million appliances needed converting (Verbong and Schippers 2000).

To maintain a constant flow of work and consistency, Gasunie and SROG approached construction company Werkspoor to undertake the work through a subsidiary NV Gascon, which eventually converted just under half the premises in the Netherlands. They feared having conversion undertaken by many smaller companies would cause a great loss of time. Werkspoor agreed to undertake conversions if they were allowed to convert at least 600,000 connections and eventually converted around one million. Due to their unfamiliarity with the conversion, Gascon worked closely with an American company in the first year, which supplied 25 consultants to the Netherlands to instruct the new gas fitters. Another company, Stone & Webster, carried out many conversions in the major cities. In Amsterdam, the city council deployed redundant workers from two shipyards threatened with closure to undertake conversions. Simple conversions were undertaken in the premises with more complex appliances removed and converted at specially equipped workshops. Trained conversion teams worked on the conversion of commercial and industrial premises (Verbong and Schippers 2000).

Public communications campaigns explained the process to the customer. Planners always tried to ensure the transition to natural gas took place as smoothly as possible. When something did go wrong, they usually succeeded in preventing major problems by acting decisively. The conversion operation peaked in 1966 with approximately 700,000 conversions. The total costs of the operation, which was completed well within the planned five-year period, amounted to approximately 650 million guilders (Verbong and Schippers 2000).

As in Britain, conversion to natural gas would cost the consumer nothing. It had been decided the gas distribution companies would bear the costs of conversion. As compensation, they were reimbursed 50 guilders per converted premises by Gasunie (Verbong and Schippers 2000).

G.H. Hellendoorn (1967) noted the town of Hilversum, where he had been the gasworks director, had originally obtained natural gas in 1956. Supplies were inadequate to enable conversion to natural gas, so the flexibility of continuing to produce town gas by the reforming of natural gas, propane, butane, and light distillate was preferred.

When in 1962, natural gas became abundant, the town decided to switch to natural gas, gas supplies trebled. In the Netherlands, the choice of fuel for space heating in properties increased from about 2% of the heating market in 1962 to 83% in 1966. Anthracite coal, which had been the market leader in 88% of the space heating market, dropped to just

5% by 1966. The cleanliness of gas being a differentiator against anthracite coal, which had been the fuel of choice previously. Although oil was cheaper than gas, the lower capital cost of gas installations over oil-fired heating was a benefit (Hellendoorn 1967).

Hellendoorn (1967) highlighted the approach taken for the conversion of gas heaters in the winter in the Netherlands. In the winter, gas heaters were converted with the utmost speed, with the following steps taken:

- Conversion of all central heaters immediately after cutting off the town gas.
- Conversion of one room heater on the first day and any others to be completed on the second day.
- The installation of loan apparatus (propane gas or electrical) for emergency cases.

Hellendoorn (1967) also highlighted the importance of good communications with the consumer, highlighting what every consumer should know:

(a) Before conversion -

why they are to be supplied with natural gas

why all their appliances will need to be altered or renewed and in which cases alteration is less advantageous than the buying of a new appliance

the possibilities of obtaining an important discount during an appliance trading-in campaign, i.e., new for old.

(b) A short time before the conversion of a sector:

conversion day date and what is planned to be done during conversion

what they are expected to do on the day or the night of the change

all measures taken and to be taken by the Board.

(c) After conversion:

how to proceed with complaints or technical difficulties.

Hellendoorn also emphasised the importance of internal communication, highlighting that everybody in the service of a gas board about to switch to natural gas should be informed what in general the Board plans to do in the near future. They should be warned not to give too many details to consumers and told questions should be referred to the Board’s Public Relations department. The importance of good planning for conversion was highlighted, with plans for sectorisation of the gas mains, for the control of the gas mains and distribution, for gas meters and for the internal pipework of premises all crucial. The approach to the conversion exercise whether it could be done in house or contracted out and even the process to closing and decommissioning the gasworks. Another important point raised was the pressure of the natural gas delivered, as this was much higher than provided by gasworks plant. How to reduce this before delivery to the customer was also highlighted (Hellendoorn 1967)

Ringelberg (2021) highlighted not all Dutch customers were happy with conversion, the smallest users did not always benefit and up to 15% of households felt duped about the costs. Some of the municipalities that used one particular conversion contractor ended up with much higher bills, while faults and leakage losses were common during the roll-out of the main gas pipelines and modifications to local gas distribution network (Ringleberg 2021).

The conversion programme in the Netherlands was regarded a success and there were no major protests. This was in part due to the joined-up approach between Gasunie, the municipalities and the media. It also coincided with a period of growth and prosperity in the Netherlands and central heating had been a long-cherished wish of the Dutch people (Ringleberg 2021).

A book looking at the lessons that may be learned from the conversion programme to natural gas undertaken in the Netherlands states the Dutch natural gas network operators have calculated it will cost around 700 million euros to make the natural gas network suitable for the supply of hydrogen to households (Ringleberg 2021).

Smith (1977) commented conversion has been completed in most major cities for some years in the USA, where natural gas had been discovered in substantial amounts in the south of the country and transported by transmission pipelines to towns and cities in the north. The USA had been visited by teams from the British gas industry regularly from the 1950s and ahead of conversion.

One US example of note was the conversion programme in Philadelphia. Charles Simpson was the Vice President of the United Gas Improvement Company and General Manager of the Philadelphia Gas Works Division. He regarded the conversion as an unparalleled success story, stating it “was accomplished without one untoward incident or impairment to customer or public relations”. The conversion was completed within six months and 1.64 million appliances were converted, affecting 685,000 customers.

Changes to the gas supplied to the customer in Philadelphia had occurred several times. In 1950, the gas had changed from a typical town gas of 530 btu/ft^3 (19.7 MJ/m^3) to 650 but/ft^3 (24.2 MJ/m^3). This change, which involved an intermediate gas with a value of 565 btu/ft^3 (21.1 MJ/m^3), required only minimal changes to appliances such as orifice changes and air adjustments. When it came to sectorising the network, it had been decided to split it in to large sectors of 50,000 customers. However, it was realised that the under and/or overgassing of the appliances, influenced substantially by the change in specific gravity of the gas, would not seriously affect the appliances, so the whole city was converted. This simple conversion was delivered for US$3.5 million rather than an expected US$25 million. The calorific value of the gas was increased again from 650 btu/ft^3 (24.2 MJ/m^3) to 700 btu/ft^3 (26.1 MJ/m^3) in late 1951, again to 720 btu/t^3 (26.8 MJ/m^3) in 1953 and then again in 1958 to 750 btu/ ft^3 (27.9 MJ/m^3). Each time the gas changed, there was a corresponding change in the specific gravity of the gas and hydrogen content (Simpson 1967).

With each of the increases in calorific value of the gas, there were subsequent financial assessments of switching the system to natural gas. The assessment made in 1962 strongly supported conversion to natural gas from what would have then been a gas of 750 btu/ft^3 (27.9 MJ/m^3). The cost of conversion was estimated at US$15.7 million and savings per year estimated at between US$3.4 million and $4.4 million. Again, a novel approach was taken different to others described in the report, where an intermediate gas of 850 btu/ft^3 (31.6 MJ/m^3) was used during conversion and very large sectors of 50,000 customers once again adopted the new gas (Simpson 1967). The success of this conversion was down to planning, as Simpson stated: “Plan! Plan! Plan! and keep repeating this as probably the most important factor of any conversion.” He identified an integral part was the involvement of all areas of the company and direct participation by many individuals. Philadelphia Gas Works (PGW) was, at this time, a vertically integrated gas company like the BGC, but privately owned. Simpson also highlighted that “in those conversions where it is anticipated that there will be an association with a contractor, this relationship is of vital importance. In essence, the integration and wedding of the two organisations must be complete.”

Simpson also stressed: “Application of the highest standards of public relations theory and practice paid off handsomely for PGW, with measurable effects on community and customer relations.” This applied equally to dealing with the media, with Simpson saying: “Being alert to the needs of and co-operation with the news media will minimise the unpredictability and uncontrollability of timing and content. In the Philadelphia experience, overwhelmingly and almost exclusively the content reflected favourably on the Company.” While the approach to conversion was quite different to that used in Britain, two key messages were clear: very detailed planning and good communications were vital.

From the few above examples, the importance of good planning and clear and consistent communications is clear. This was aided by the availability of technical support and research capability. While there are key aspects of different international conversion programmes that are very similar, they also show different approaches to conversion can be taken.

12. Conversion terminology, notes and statistics

The following terminology used during the time of conversion is taken from a range of different sources.

Table 12.1 Terminology used in the Report and during the conversion programme.

Terminology	Description
Appliance Survey	Every premise in each street was visited to identify the type and number of appliances.
Call Back	Although great care was taken at the time of converting the appliances, minor adjustments were necessary to appliances and, to enable this work to be carried out, mobile caravans were left on **Sector** for three weeks after **C.Day** to enable defects to be reported. A specialist team of mobile **Call Back** fitters would visit premises to carry out these adjustments.
C(onversion). Day Minus 1	Conversion crews would visit the **Sector** to be converted the following day and try to gain entry to as many premises as possible. Firstly to remind the customer of the conversion programme, secondly to check appliances to ensure no appliances had been changed since the original survey. This enabled replacement kits to be ordered if necessary and allowed some appliances not in use to be converted ready for new gas.
C.(conversion) Day	In the early hours in the morning of **C.Day** engineers would check the valves in readiness to turn off the town gas. Conversion crews would arrive on **Sector** usually about 7.30am to make safe.
Conversion Area	A designated geographical locality comprising one or more sectors that will be converted on a continuous programme.
CU4	A region would be split between **Conversion Units** to identify the location for conversion, each unit given a number e.g. **CU4**
Sector	When the **Appliances Survey** had been completed, the streets would be grouped into areas known as **Sectors**, usually of about 1,000 appliances.

Terminology	Description
Sector Valving	From the **Appliance Survey**, the proposed **Sector** would be checked to establish if suitable valves could be installed in readiness for conversion.
Sector Posting	When engineering surveys had confirmed the **Sector** size, each premises would be given a **Sector** and premises number. The conversion kits would be ordered and the customer advised of the date of conversion.
Pre-Conversion Work	Some industrial and commercial appliances required major conversion and, to enable a quicker conversion on **C.Day**, some of these appliances were pre-converted while still burning town gas.
Flare Off	Before the supply of gas to any premises could be turned on, the mixture of town gas and natural gas in the main and services of the **Sector** would have to be purged. This would normally be done from a **Flare Off** point situated in the road or footway, which was controlled by an engineer who would watch the gas burning until the neat blue flame of natural gas showed at the **Flare Off** point.
LNG	Liquefied Natural Gas, Gas cooled to –162°C to enable its volume to be reduced to 1/600th so it can be transported more efficiently as a liquid.
Main Runner	An appliance outside the 15 years rule whose population is such that the provision of a conversion set will be required.
Make Safe	Before natural gas could be introduced to the **Sector**, the gas supply to each premises was turned off. This was an important operation and no further work could be carried out on the introduction of natural gas until it was confirmed every premises had been turned off (i.e. **Made Safe**). At the same time, the conversion fitter would test the internal supplies to the house to ensure there were no gas leaks.
Mobile Workshop	Most appliances required simple conversion in consumers' premises, but some appliances required major conversion at the **Mobile Workshop** sited on the **Sector**.
Terminology	**Description**

Terminology	Description
NGTS	National Gas Transmission System, the high-pressure gas transmission system that grew out of the original **NMP**, which distributed natural gas from the North and Irish seas and imported LNG.
NMP	National Methane Pipeline, the original part of the **NGTS**, running from Canvey Island to Leeds and supplying eight regional gas boards.
Priority Appliances	In most domestic premises, the natural gas supply would be available by midday of **C.Day** and most consumers would have their cookers converted. In the winter, some form of heating was operational by the end of **C.Day**. Each conversion fitter would normally have about eight premises to convert and, when visiting these premises, would give priority to vulnerable customers. In commercial and industrial premises (some of which were pre-converted), specialist crews dealt with these as quickly as possible on **C.Day**, enabling these companies to return to their normal operations.
Sector Communication	The size of a **Sector** (determined by the number of appliances) in central London could be as small as one or two streets but in rural areas they could be several square miles. To enable swift communications between the conversion crews, a mobile radio control vehicle was based on **Sector**. Supervisors were given radio handsets, which enabled them to communicate with the operations manager on the control vehicle. In addition, the operations manager could contact the conversion unit base office, which could be 20 to 30 miles away.
Turn In	Once **Make Safe** had been confirmed, the engineers would turn off the **Sector** valves, stopping the flow of town gas to the **Sector**, and would open the valves from an adjacent **Sector** that had been converted to natural gas to flow into the **Sector**.
Turn On	Once the mixture of gases had been purged from the mains, the conversion crews were advised that, when the appliances had been converted, they could be **Turned On**, tested and adjusted to burn the new gas.

Terminology	Description
NTGB	North Thames Gas Board, known after 1973 as the North Thames Gas region of the BGC.
SEGB	South Eastern Gas Board, known after 1973 as the Southern Eastern Gas region of the BGC.
SoGB	Southern Gas Board, known after 1973 as the Southern Gas region of the BGC.
SWGB	South Western Gas Board, known after 1973 as the South Western Gas region of the BGC.
EGB	Eastern Gas Board, known after 1973 as the Eastern Gas region of the BGC.
EMGB	East Midlands Gas Board, known after 1973 as the East Midland Gas region of the BGC.
WMGB	West Midlands Gas Board, known after 1973 as the West Midlands Gas region of the BGC.
WGB	Wales Gas Board, known after 1973 as the Wales Gas region of the BGC.
NEGB	North Eastern Gas Board, known after 1973 as the North Eastern Gas region of the BGC.
NWGB	North Western Gas Board, known after 1973 as the North Western Gas region of the BGC.
NGB	Northern Gas Board, known after 1973 as the Northern Gas region of the BGC.
ScGB	Scottish Gas Board, known after 1973 as the Scottish Gas region of the BGC.
BGC	British Gas Corporation, the organisation formed from the merged 12 regional gas boards on 1st January 1973, following the Gas Act of 1972.

Table 12.2 National conversion programme Statistics (Elliot 1980)

	Customer Conversions ('000)			Appliances Converted ('000)	
Year	Domestic	Commercial	Industrial	Domestic	Commercial
1966-67	7.8	0.1	0.0	1,061	47
1967-68	42.2	0.6	0.3		
1968-69	400.5	15.2	2.5		
1969-70	1,050.5	36.8	5.0	2,580	194
1970-71	1,972.3	52.6	7.9	4,887	306
1971-72	2,322.1	69.3	10.5	5,940	374
1972-73	2,036.7	56.8	8.0	5,096	314
1973-74	2,049.7	51.8	7.2	5,097	329
1974-75	1,611.4	54.4	7.6	4,096	353
1975-76	1,087.0	37.4	6.6	2,801	239
1976-1977	319.2	8.9	1.4	778	57
1977-78	95.4	2.3	0.3	214	13
Total	12,994.8	386.2	57.3	32,550	2,226

Table 12.3 Regional conversion programmes – Customer Conversions (Elliot 1980)

	Customers Converted		
Regions	**Domestic ('000)**	**Commercial ('000)**	**Industrial ('000)**
Scottish	817.1	20.7	3.0
Northern	702.8	21.8	1.0
North Western	1,770.5	64.9	12.4
North Eastern	840.4	35.6	5.9
East Midlands	1,320.7	24.3	5.0
West Midlands	1,233.9	35.8	6.3
Wales	510.8	27.3	0.7
Eastern	896.2	19.7	4.0
North Thames	1,845.6	49.8	11.5
South Eastern	1,735.0	34.4	4.1
Southern	756.4	21.3	2.0
South Western	565.4	30.4	1.4
Total	12,994.8	386.2	57.3

Table 11.4 Regional conversion programmes – Commencement and Completion

Region	Commencement Date and Location	Completion Date and Location	Length of Programme
Scottish	June 1970 Kelso	Sept 1977 Edinburgh	7 Years 3 months
Northern	April 1969 Penrith	July 1975 Newcastle upon Tyne	6 Years 3 months
North Western	March 1968 Saddleworth	February 1976 Stockport	7 Years 11 months
North Eastern	Sept 1967 Withernsea	January 1976 Ossett	8 years 4 months
East Midlands	May 1967 Alrewas	August 1974 Ulceby	7 years 3 months
West Midlands	July 1968 Coleshill	August 1976 Bromford	8 years 1 month
Wales	April 1969 Colwyn Bay	June 1974 Bridgend	5 years 2 months
Eastern	April 1968 Hitchin	November 1974 Harpenden	6 years 7 months
North Thames	April 1968 Corringham	August 1976 Beckton	8 Years 4 months
South Eastern	June 1969 Cranleigh	June 1976 Biggin Hill	7 years
Southern	June 1968 Bletchley	February 1975 Reading	6 years 8 months
South Western	April 1970 Wickhamford	November 1975 Bristol	5 years 7 months

13. Lessons learned for a future transition

This report has reviewed the published papers, articles and films produced during the period from the end of World War II until the completion of the conversion programme. It has been supported by the views of those who worked on the conversion programme and has identified some useful learning that could inform a future energy transition in the gas sector.

13.1 Planning, organisation and structure

The conversion programme was, in the words of Chairman of British Gas from 1976 until 1989 Sir Denis Rooke, “perhaps the greatest peacetime operation in the nation’s history”. Given the much larger size of the gas network today, any similar type of conversion is going to be of a much greater scale.

The findings of this report would echo the words of Charles Simpson, who led the conversion programme in Philadelphia (USA), and said “Plan! Plan! Plan!” was the key aspect of conversion. His thoughts were echoed by J.R. Finnigan of NEGAS, who stated that “If conversion is not underestimated, there is good planning, adequate facilities, a high degree of technical ability and manual dexterity, coupled with a will to win, then conversion is easy”. **Good planning from the start would be a key lesson to learn for any future conversion of the gas network**.

Some of the most important planning for conversion could be traced back to nationalisation and the creation of the regional gas networks. These, although designed for more efficient distribution of lower cost town gas from larger gasworks, became vital to the distribution of natural gas. Distributing gas without them would have been impossible. Nationalisation had delivered this integrated structure, parity with its main rival (the Central Electricity Generating Board) and its main supplier (the National Coal Board) and cheaper access to finance through the government. Amalgamation into regions based on private ownership using the model of the Gas Light and Coke Company could have been feasible.

A vertically integrated business, which covered everything from gas manufacture through distribution and the sale of gas and appliances to the customers, certainly eased the job of conversion. To the customer and other stakeholders, gas had one face, that of the regional gas board. The Gas Council was not particularly visible to the public. The gas industry was not identical everywhere, with each regional gas board being slightly different due to its autonomy. While this worked for manufactured gas, it was not ideal for North Sea natural gas, a factor Gas Council advisors McKinsey and the Government acknowledged. To enable an efficient conversion to natural gas, it was thought a centralised single structure, the British Gas Corporation, was required. As it was not possible to create this structure until the start of 1973, the 12 regional gas boards had to cede some power to the centralised Gas Council to enable conversion to run smoothly.

There is no doubt the centrally coordinated approach made possible by a vertically integrated and state-owned structure provided the certainty and aided the pace at which the programme was completed. This centralised structure allowed long-term planning and cooperation and enabled the recruitment of the best people for the roles in the industry. It also enabled a swift restructure of the gas industry, with great centralised coordination through an empowered Gas Council.

The committees formed through the Gas Council Conversion Executive and the support it received from its centres of technical excellence (e.g. Watson House and MRS) enabled standardised methods to be developed and learning to be quickly disseminated. It was more efficient because it could negotiate with suppliers as a single customer, rather than 12 competing customers. Centralised purchasing provided a major saving in procurement costs and helped when working with the manufacturers of appliances in the provision of conversion sets and new appliances. For communications with customers, it provided one face and voice for the gas industry.

It is hard not to compare the very different structure of the gas industry during conversion and that which exists today. From state ownership of a vertically integrated industry in the period 1966-1977 to the current highly fragmented industry split into many different aspects ranging from gas production, energy trading, transmission, distribution, storage, servicing and sales. At the time of conversion, despite the use of contractors, all the key functions and decision makers were within the same organisation. While there is no suggestion of recreating the BGC, organisations will need to work collaboratively across the whole energy sector to transition to a new net zero future. At the time of conversion, there were just under 13 million domestic gas customers. While exact numbers for those with central heating are not available, it was estimated that, even in the most prosperous areas, only 30-40% had gas central heating at the time. According to the 2016 Committee on Climate Change report ‘Next steps for UK heat policy’, there were 23 million residential customers connected to the gas network. According to the 2021 census for England and Wales and the 2017 census for Scotland, 74% and 77% of homes respectively have gas central heating. This shows the different nature of the challenge for conversion today. A much larger population of the country is dependent on gas to meet its heating demands.

A key lesson for any future conversion of the gas network would be to have an appropriate organisation and structure in place that allows the industry to work together in a coordinated fashion with clear objectives and communications.

13.2 Certainty and financial

From 1949, the gas industry in Great Britain had come under the ownership of the government. Through nationalisation, the industry was controlled directly by government and directly accountable to a government minister. For the conversion programme, this provided financial security because the gas industry could borrow money directly through the government and therefore certainty the project would be followed through. When Sir Henry Jones announced Britain's switch to natural gas in 1966, this was with approval of the government. It was not a partial commitment but a full commitment to convert the whole gas infrastructure from town gas to natural gas. The approach was supported by strong technical, economic, environmental and safety-based justifications and greatly benefited the country. This commitment, however, was made with little or no public consultation, a situation hard to envisage today.

Without clear, concise and strong government support and financial backing, the decision to convert the country would have been delayed. This would have meant wasting money on new gas-making plant and importing oil feedstocks from abroad and lost revenues on North Sea gas sales. It would also have prolonged the use of toxic town gas and delayed the move of energy consumers away from more polluting fuels, which should be a key consideration moving forward today.

A key lesson learned was the certainty that came from strong government support enabled long-term investment decisions to be made to enable the conversion programme to proceed. Delays that could have occurred in the natural gas conversion programme have an opportunity cost. Not just economic, but also environmental and safety-related. Not only might industry move to other countries where the energy transition is more advanced, the opportunity for new green industries in Britain may be lost.

Despite the cost and potential challenges conversion faced, the advantages of complete conversion were overwhelming. There were enormous technical advantages of distributing methane without dilution: processing costs would be minimal and the capacity of gas mains was at least doubled. The gas was safer as it would not contain carbon monoxide and it would convert energy users to a cleaner fuel than many were already using, such as coal or oil. Against this had to be set the technical challenges of conversion, the cost of converting every appliance (or replacing them) so they could burn natural gas and the inconvenience and intrusion customers would face.

There were considerable financial drivers for the switch to natural gas. The gas industry estimated the cost of building new plant to produce town gas alone would have been

£1.4 billion in 1969 terms (£7.7 billion today), money which it would save. Conversion more than doubled the capacity of the gas network by increasing of the calorific value of the gas supplied from approximately 500 British Thermal Units per cubic feet (Btu/ft^3) (18.6 Mega joules per cubic meter (MJ/m^3)) to 1000 Btu/ft^3 (37.2MJ/m^3) and by increasing the pressure of the gas within parts of the gas network. The government saved an estimated £100 million per year in foreign currency conversion costs, money that would have gone on the import of oil and gas. Customers after conversion received a discount on the price of gas and discounts on new easy-to--convert bi-fuel appliances available from the gas showrooms. Everyone benefited and it made the inconvenience caused easier to accept.

Using the Bank of England inflation calculator, the estimated £600 million cost of the programme would now equate to £3.3 billion. The average cost of conversion for each household during the natural gas conversion programme was estimated at £43. Using the BoE inflation calculator, this would equate to £239 per customer and with the 23 million gas customers today, £5.5 billion in total. However, it is difficult to draw an exact comparison between the two.

Conversion of today's network would cover many more kilometres of pipe, more customers and higher consumption levels. Much of the existing gas infrastructure could be repurposed, but new hydrogen plants would be required, with an increased need for hydrogen storage capacity and carbon capture and storage. Most gas appliances today are newer, there is less variety, very few water heaters and no portable appliances. However, there has been a substantial increase in gas-fired central heating boilers, from about 30-40% in the most affluent areas during conversion to between 74-77% in Britain today. There is much debate on who would bear the cost of such changes, but there is consensus that an uptake of hydrogen in industry would stimulate cheaper costs for domestic consumers.

As Charles Elliot made clear in his book on the natural gas conversion programme, the Government needed to be as committed as industry to supporting a long-term transition in the gas industry. For a future transition to a new fuel gas such as hydrogen, a clear message from government and long-term commitment is essential to support such a large investment.

13.3 The National Gas Transmission System and the interconnected network

When the natural gas conversion programme was first embarked on, the gas networks were largely operating in isolation from each other. Conversion to natural gas was only feasible with the corresponding construction of the infrastructure required to supply natural gas. This included the offshore gas production rigs, offshore gas pipelines, gas reception terminals and the National Gas Transmission System (NGTS). Except for the National Methane Pipeline, which stretched from Canvey Island to Leeds, all the other infrastructure had to be built to get the natural gas from the production wells to the distribution networks. With only a few shore terminals constructed, the infrastructure could be readily planned around this.

With a possible future transition to new fuel gas such as hydrogen, there may different challenges. Instead of a few shore terminals, hydrogen production could be distributed more widely across Britain. Production could be intermittent if, for example, hydrogen is being produced from surplus renewable electricity, which would then require buffering in large underground storage facilities. To enable a conversion to a new fuel gas, something equivalent to the NGTS to supply the new fuel gas or a gradual repurposing of the NGTS would be required. This would have to occur while maintaining the supply of natural gas to those areas still using it. A guaranteed supply of the new fuel gas will also be required along with seasonal and possibly diurnal storage. Conversion was only achievable with the guaranteed supply of a new fuel gas and the associated infrastructure to deliver that gas, which would be a similar requirement in any future hydrogen conversion.

During the last conversion programme, distribution engineers were required to determine the exact location of all mains, valves and services. While the gas networks are now much more extensive, given the digitization of underground assets today, such information should be already to hand, ensuring this aspect of conversion should be more straightforward.

Today, the gas network in Britain is not isolated and any developments will have impacts on third parties unless the emerging gas network forms into separate hydrogen and natural gas networks. For example, the Isle of Man, Northern Ireland and the Republic of Ireland are currently dependent on natural gas supplied from Great Britain. There are also potential implications for the natural gas imported into Great Britain from Norway and the import and export of gas via interconnectors with the continent. None of these were factors that needed considering before. Coordination will have to be managed at a regional level within the GDNs, at a National Level with the Gas Transmission System and at the international level with the LNG import terminals and through interconnectors/international pipelines with the Isle of Man, Northern Ireland, Republic of Ireland, Norway, Belgium and the Netherlands.

At the time of conversion, the global energy market was not as clearly defined as it is today. The gas infrastructure in Britain was itself only just being connected regionally by the NGTS. There were no interconnectors linking British gas infrastructure to Ireland or mainland Europe as is the case today. Gas prices had become strongly influenced by the prices of oil due to the new dependence on refinery by-products as they had been on British Coal before that. With the advent of North Sea gas, lengthy negotiations were held with those companies exploiting North Sea gas to agree prices. Today, gas in Britain can be imported from more sources and exported, its wholesale price being set on an international market rather than between just two parties as in the 1960s. If Britain and the rest of Europe move to hydrogen-based gas networks, the timing and phasing of conversion may have direct impacts on other third parties. For example, Norway and the Republic of Ireland, whose gas supplies flow through Britain and those LNG import terminals that deliver gas through the UK's gas network.

13.4 Safety and new fuel gases

The gas industry learned much from the conversion programme that improved the safety, operation, communications and performance of the industry. It provided a one-off chance to inspect the condition of Britain's gas infrastructure, from distribution to appliances. It would be fair to say it was not all good news, with much substandard work found and many appliances in need of servicing. These findings stressed the need for new Gas Safety Regulations and for setting up Confederation for the Registration of Gas Installers (CORGI). CORGI would ensure independent gas installation contractors maintained satisfactory standards of work. Items deemed unsafe, such as portable gas heaters that were supplied with gas via a rubber hose and had no venting, were banned because of improved safety standards. Gas Safety Regulations (1972) were brought in during the conversion programme and the whole of the country's gas infrastructure was much improved. An equivalent conversion programme today to change to a different fuel gas such as hydrogen would be unlikely to find the same problems. Safety standards today are much higher and the risk of DIY or unqualified gas fitters installing or repairing installations is much lower. New fuel gases may mean new regulations and safety standards being adopted, so changes could be driven by this.

A key lesson learned was the whole gas infrastructure had to be investigated, safety tested and upgraded to ensure it was suitable for natural gas, which required the development of new safety standards. A similar approach would be required today for developing new standards and guidance for appliances and the wider gas infrastructure for hydrogen or any other fuel gas with different properties and would need the involvement of stakeholders such as the Institution of Gas Engineers and Managers.

A new fuel gas such as hydrogen would require new infrastructure to produce the gas from processes such as electrolysis or gas reforming technology. Manufacturing, storing and distributing hydrogen is certainly nothing new: even back in 1930s, the Hydro-electric Power Commission of Ontario had its own Electrolytic Gas Department. This was producing hydrogen and oxygen from the electrolysis of water using hydroelectricity or surplus electricity from coal-fired power stations. Even in 1937, hydrogen use in industry was estimated at 566 million m^3, coming from either electrolysis or water gas production. In Norway at the same time, a hydroelectric power scheme had substituted power lines for pipelines and was exporting 283 million m^3 of hydrogen and oxygen gas per year, two thirds of which was used for fertiliser production.

13.5 Storage capacity

The natural gas infrastructure was designed as a single interconnected system and gas storage was an integrated part of it. The planning for conversion in 1966 had foreseen the need for increased gas storage to meet increased seasonal demand. This had been proposed in suitable underground rock formations that had a gas tight caprock, which had already by used on a small scale by the NGB and NWGB.

By 1970, the most important form of storage had been identified as LNG. This was already in existence at Canvey Island using specially designed, insulated above-ground tanks. In addition, four frozen ground storage tanks were also built. These used the low temperature of the LNG to freeze the ground surrounding the tank, making it gas tight. The ground conditions at Canvey Island proved to be unsuitable and the tanks had to be decommissioned.

The BGC built future above-ground LNG storage at locations where it was thought strategic supplies would be required. These were Glen Mavis (Scotland), Dyvenor Arms (South Wales), Avonmouth (Bristol), Partington (Cheshire), Isle of Grain (Kent) and Ambergate (Derbyshire). The Glen Mavis site also supplied LNG to the Scottish SIU that had adopted LNG.

The need for storage was clear to the industry, which had manufactured gas before conversion, when gas storage was accountable both in feedstocks (coal, coke, oil, and natural gas) that would be converted to town gas as well as the diurnal storage in gasholders. Ultimately after conversion to natural gas, the seemingly infinite local supply of North Sea gas dissuaded the industry from building further large-scale underground storage until the construction of the underground storage facility at Attick (Hornsea) in 1979 and the Rough Storage facility in a depleted gas field in 1985.

The gasholders that had been used for diurnal storage became redundant, as this storage could be met from line pack storage in the NGTS and high-pressure tiers of the gas distribution network.

A switch to hydrogen would present a new challenge. Given the lower calorific value of hydrogen (approximately 316 btu/ft^3 or 11.7 MJ/m^3) as a potential new fuel gas and the need for a resilient energy system. The gas industry would require considerable additional gas storage capacity at key locations in the gas networks, most likely in salt caverns or depleted gas fields for seasonal storage, and some form of gasholders such as high-pressure bullet tanks or pipe arrays for diurnal storage.

A key learning from the conversion programme was that the gas infrastructure was developed by the BGC as an integrated system able to meet the demands placed on it. The structure of the gas industry today is much more fragmented. meaning greater collaboration would be required to overcome this challenge.

13.6 The supply chain, technical support and logistics

During the conversion to natural gas, most of the supply chain was UK based and British appliance manufacturers dominated the market, with most UK-made appliances developed in tandem with research departments such as Watson House. There was a similar situation with manufacturers of gas infrastructure such as pipes and valves. This made working with these manufacturers easier to coordinate and influence than would be the case today, where much is manufactured abroad. Similarly, the regional gas boards developed a close relationship with their contractors, which facilitated the smooth operation of the conversion programme.

A key learning from the conversion programme was that early engagement and close cooperation with suppliers and contractors was vital to its effective delivery. Early engagement with suppliers and contractors to provide delivery timelines would be beneficial to any future conversion programme.

Much of the success of conversion was a result of co-operation shown by the manufacturers in the enormous job of developing and providing conversion sets and by Watson House in approving and improving them. Watson House also played a key role in the identification of appliances, producing the identification manuals used by surveyors and fitters. As Hindmarch stated: “Accurate surveys means successful conversion, successful conversion means contented consumers, contented consumers are the ambition of the Conversion Department.” All this work had to be done in a remarkably short period of time. In the long run, the day-to-day commitment of the technical staff of boards in the enormous fieldwork programme was equally important. **A key factor in the success of the conversion programme was the close working relationship between the technical experts (Watson House and MRS), the Gas Council and the regional gas boards. The key learning is the need to have similar working relationships with the likes of IGEM and any other organisations established to support future hydrogen conversion.** Finding a modern equivalent to Watson House will be a challenge. Its role was pivotal, providing significant technical support throughout the conversion programme.

The vertically integrated regional gas boards and the British Gas Corporation required considerable storage capacity to handle everything from pipes to appliances. This was expanded during the conversion programme and primarily used for appliances, meters and spares, though sometimes appliance refurbishment and repair were also undertaken in adjacent workshops. These stores and the logistics capability to receive, manage and dispatch a large number of different items was vital for effectively handling conversion sets. The gas industry also had its own transport division, which transported conversion kits and mobile conversion bases. **A key learning from the conversion programme was the vital importance of logistics supported by the supply chain in ensuring everything and everyone were where they should be.** As the gas industry in Britain is no longer vertically integrated and has been fragmented into smaller businesses, it no longer retains these stores and logistics capabilities. It would need to engage early with the supply chain and partner with a logistics firm to provide this essential support.

13.7 Training and skills

During the previous conversion programme, the gas industry established regional centres for the training of workers carrying out conversion. To provide similar training today, a partnership would have to be established with the gas distribution companies, contractors and higher education institutes. This would need to be established before the onset of conversion due to the lag between training and becoming qualified. The selection of staff suitable for working on the natural gas conversion programme was important as it was felt they were representing the wider industry as well as their contractor and regional gas board.

The training programmes devised at the time of conversion would not be as extensive as that required today. At the time, CORGI was only just coming into existence and there were no Gas Safety (Installation and Use) Regulations. In today's safety regime, all premises require a 'competent' person to test and recommission pipework and appliances. There would currently be nowhere near enough trained gas engineers to tackle a conversion programme and training is far more extensive than in the time of conversion.

Given the lower number of jobs in the UK engineering sector today compared to the 1960s and 70s, the availability of workers with the practical engineering skills may be a limiting factor. Some thought may be required to persuade retired engineers to return to the workforce, albeit on a temporary basis, to plug the skills gap while new staff are trained.

A total workforce of 20,000 conversion engineers was required for the 10-year conversion programme to natural gas, 10,000 of whom were working at any one time. Since then, the amount of gas supplied and the gas distribution network have grown substantially, increasing the number of premises that would need to be visited. The number and diversity of appliances in the home will have fallen, as items such as water heaters and gas-powered refrigerators and warm air systems are now seldom used. Commercial and industrial appliances would provide a similar challenge as before due to their often-bespoke nature.

It would not just be the recruitment and training of engineers that would be required, but many other staff to undertake surveys, perform data collection and processing, manage programmes, logistics, transport, customer support, communications and public relations. The management of the large amounts of customer data and compliance with GPDR will be a challenge in itself.

A key lesson from the conversion programme was staff training had to be addressed at the start, establishing training schools, a workforce of trainers and a suitable syllabus and training programme, which would be important to take forward in future hydrogen conversion. The higher standard of training for gas engineers today would likely require long training periods. Whatever direction the energy transition takes, a large workforce will be required to decommission old systems and install new ones, manage the programmes and provide back office support.

The gas industry at the time of conversion required a much wider range of technical skills than it did after conversion. This is because gas was being manufactured at hundreds of sites across the country, using a wide range of different gas making plant and feedstocks. Skilled staff such as chemists and chemical engineers were as integral a part of the workforce as the mechanical and gas engineers who worked on gas distribution and transmission. These wider skillsets played a vital role in the conversion process, two such examples being Sir Kenneth Hutchison, a chemist, who as Deputy Chairman of the Gas Council oversaw the earliest stages of conversion, and Sir Denis Rooke, a mechanical and chemical engineer, who was actively involved all the way through conversion, eventually becoming the Chairman of British Gas.

If the industry is going to transition to a green gas network, it will need a wider skillset beyond appliance conversion, gas distribution and transmission. New skills would be required for the complex mixture of manufacturing gas from carbon rich feedstocks and capturing CO_2, producing gas through electrolysis from renewable and nuclear energy sources, biogas manufacture and underground gas storage.

13.8 Public relations and customer experience

The advent of nationalisation brought together centralised Public Relations and Communications activities within the Gas Council and regional gas boards. This had continued the work of the British Commercial Gas Association (BGCA), which had provided a similar industry-wide role pre-nationalisation. The BGCA had produced booklets about how the gas industry operated and gas was made, which was replicated by some of the larger gas undertakings that had their own public relations departments. Following nationalisation, the coordination through the Gas Council (and later BGC) of public relations and communication was a vital strand in educating the public at national, regional and local levels about the gas industry. The public had been informed about natural gas and the import of LNG at Canvey Island before the discovery of North Sea gas, so when the decision to convert was made, public relations functions continued delivering the same messaging to the public. This clear messaging was provided to ensure, from a customer perspective, it was all being undertaken by one organisation and was business as usual.

A key lesson from the conversion programme was clear communication at a national level by the government and gas industry was vital to successful public engagement and will be equally important in any future hydrogen conversion.

The decision to convert to natural gas in 1966 was made by the Gas Council with government sanction but little public consultation. The consumer was given the stark choice of converting to the new gas or changing fuels. Public relations had the role of persuading the customers of the strong technical, economic, safety and environmental justifications for the switch and how this would benefit them.

An important aspect of conversion was access to staff at the gas board showrooms, which were widely available in all towns and cities with a gas supply across the country. The showrooms provided a place to buy appliances, pay gas bills, learn about new appliances and home improvements and watch cooking demonstrations, since many had their own demonstration areas. These were undertaken by the Home Service, which played a key role in assuring gas customers, especially vulnerable customers. The Home Service visited vulnerable customers' homes before and after conversion. These knowledgeable representatives of the regional gas boards were often trusted by customers, who welcomed their visits. The showrooms and the Home Service provided an important customer-facing aspect of the gas industry, building links and trust with the local community. **A key lesson from the conversion programme is the benefits brought by community level involvement with consumers.** Delivering such a consumer-facing approach in a future energy transition may be a challenge.

Managing the public relations around the intrusion into people's homes was a challenge, but one that was largely achieved without the need for too many disconnections. Today, customer attitudes may be different and the challenge greater. Many homes were vacated in the day and customers were willing to leave keys with neighbours or the gas company and allow conversion to proceed when homeowners were away. Attitudes to this may be partly off-set by post-Covid flexibility for some to work from home.

The clean air act of 1956 had been strongly supported by the gas industry, with the subsequent drive to smokeless fuels, which included gas and coke (a gas industry by-product). The development of gas reforming technologies had made gas cheaper and cleaner and led to the industry rebranding itself with a new marketing effort called 'High Speed Gas'. Its new cleaner image and reduced costs drove up gas sales before conversion. When North Sea natural gas was found in substantial quantities with a low sulphur content, there were undoubted health and environmental benefits from switching as many consumers as possible from more polluting fuels to natural gas. The absence of carbon monoxide in the unburnt gas also made it safer than town gas. The conversion of industrial customers to natural gas away from coal and oil brought significant environmental benefits to the country, since this sector experienced a six-fold increase in gas sales.

The wider public relations message for the conversion programme was a clear one: that everyone would benefit. The industry would benefit from avoiding investment in new gas making plant, the government would benefit from not losing money on foreign currency conversion costs and oil imports, the consumer benefited from safer and cheaper gas and discounted new appliances and the environment benefited from moving customers away from more polluting fuels.

Any change in the gas supplied to customers through an energy transition to green gas and hydrogen will require a multi-faceted approach. Such a significant decision would have to be made by government. Not only will technical issues have to be conquered, but equally, bigger issues will have to be addressed through education, publicity and communications. Such challenges will be required to build trust with multiple stakeholders including industrial, commercial and domestic users. Upfront mass communication and marketing to explain about the industry and the process and how switching to a new fuel gas will help benefit society will be required.

The natural gas conversion programme demonstrated it was technically feasible to convert the gas network in Britain to a new fuel gas with different characteristics. This was at a time when more rudimentary technology was available than today. Should such a source of new fuel gas with different properties become available, it would be feasible to convert the gas network again. The bigger challenges may be in gaining government support, planning the programme, training a suitable workforce and communicating this message clearly to the customer at the appropriate time. This will require the government and the energy industry working together and speaking with a single clear voice. Energy transition will occur as the status quo is not feasible for the long term. Whatever decisions are made it will incur change and like all change it is unlikely to be popular.

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